# INFINITE ENERGY™

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Cold Fusion • New Energy • Renewable Energy

Volume 7 • Issue 41 • 2002

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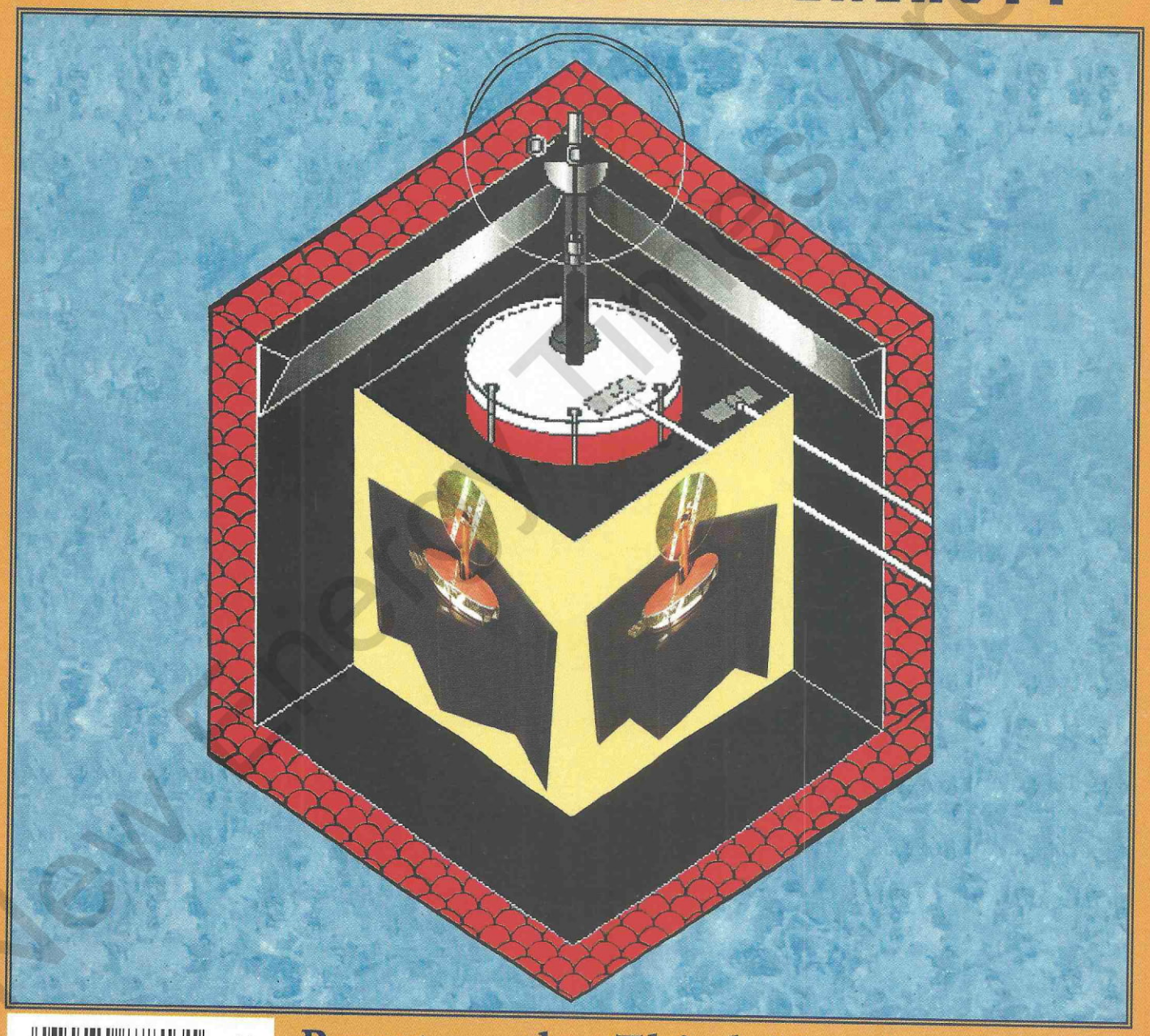

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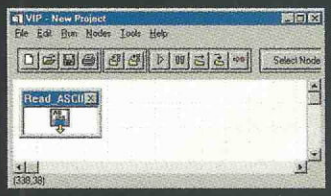


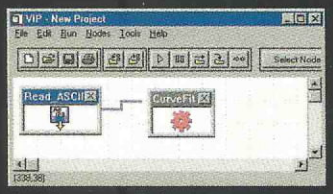


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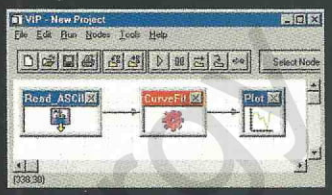


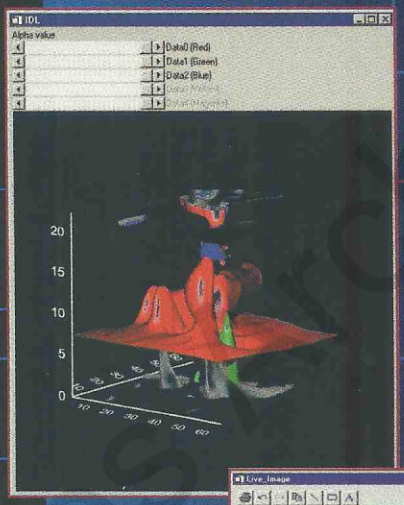

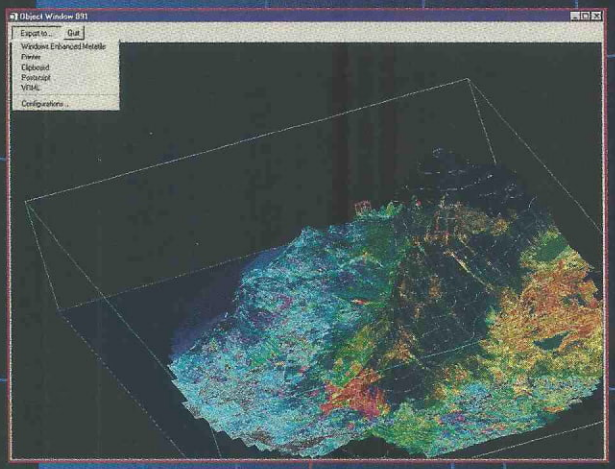


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**Cover Art:** Barbara DelloRusso (original figure of Stirling engine/HYBORAC provided by P. and A. Correa, inset photos by E. Mallove)

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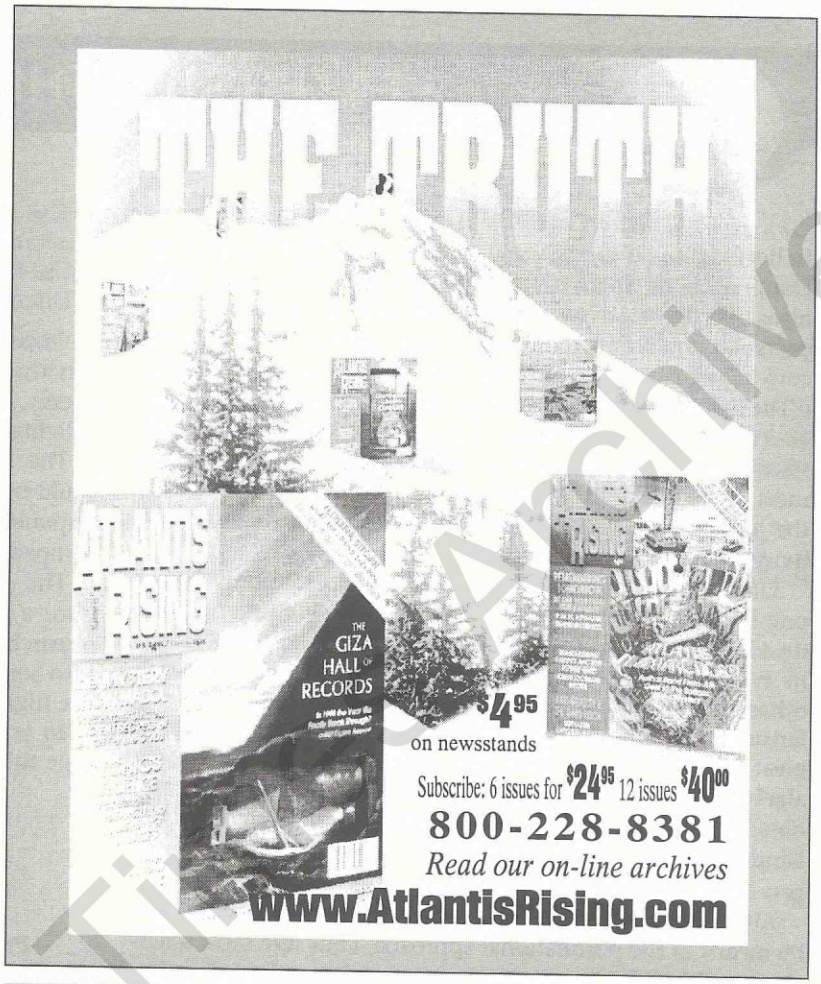


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# LETTERS TO THE EDITOR

### Give Credit Where It Is Due

In her long and distinguished career as a dissident physicist, Dr. Domina Eberle Spencer has produced many very important ideas that the rest of us would do well to learn about. One suspects she would wish to introduce such ideas in a palatable and convincing manner. But in her recent article in *Infinite Energy* ("The Eternally Valid Concepts in Einstein's Work," No. 38, pp. 88-91), she takes what seems to me to be an opposite tack, by starting with a highly inappropriate claim that is likely to turn most readers away: she gives Einstein great credit for "having the foresight" to base his special and general theories of relativity "on *clearly defined postulates*."

Limiting my comments to special relativity (SR) only, let me point out that I have heard Dr. Spencer agree with many other dissident scholars that the most fundamental flaw in SR is that its two basic postulates are logically inconsistent with each other, thus rendering the theory invalid. But if this is the way Einstein used the postulational approach, then giving him great credit for this usage is like crediting someone for using algebra, when the usage consists of adding 2x and 3x and obtaining 23x as the result; or like crediting the designer of the Hindenburg for showing how feasible it is to transport passengers across the Atlantic by dirigible.

Although it is possible to do worthwhile theoretical science by means of the postulational approach, I am sure most scientists would prefer to speak of stating a "hypothesis," rather than a "postulate." This lends more of a sense of tentativeness to the proceedings; and science should by all means be tentative, in the sense that it should be always ready to change when new data is encountered. In these terms, "working hypothesis" might be an even more appropriate term, since it emphasizes readiness to change.

If Dr. Spencer had omitted the several lines devoted to her inappropriate praise of Einstein's use of postulates, she might have found some extra space to make her own theoretical material clearer and more convincing; there is need for such improvements.

John E. Chappell, Jr.
San Luis Obispo, California

### Demonstration Units Necessary

I enjoy your magazine. It leads to much additional thinking "outside the box," to coin a phrase.

When I worked for Pacific Gas and Electric Company in San Francisco, I received a letter from an organization that claimed to produce heat from cold fusion on a routine basis such that they could boil the water in the cell. They wanted PG&E to fund their research. Our research department declined the honor.

I personally wrote them back with the idea that if they were routinely producing steam they should set up a demonstration project like this:

1. Use external DC electrical energy over a number of hours to start the cell producing excess heat (steam). (Their claim.)
2. Use the steam from the cell to drive a toy steam engine.
3. Use the toy steam engine to drive a thimble-sized DC generator.
4. Use the DC current generated to supply the cell.
5. Disconnect the external DC power source.

Once they could set up a "perpetual motion" system like this that could keep running without an external source of energy, I could guarantee that electrical utilities would be delighted to provide them with large sums of research money.

The twenty-three-year old "president" of the company could not understand what I was talking about and their correspondence ended in frustration and bitterness that a big company would not fund them.

The concept is still good. Until an organization can produce a good operating demonstration, big companies with research funds are going to be reluctant to fund research into something that has been so thoroughly denounced by the high-energy physics establishment.

In your discussions with researchers, you might want to urge this concept on them.

Douglass Ohmen
Livermore, California

### Progressives Need to Embrace New Energy

The development of new energy, cold fusion, and similar advanced energy technologies has encountered various forms of opposition from our own government. Information on this problem has appeared in *Infinite Energy*. What puzzles me is the apparent lack of interest by the major environmental organizations and the so-called "progressive" political parties. They all talk about environmental pollution and urge greater efficiency and conservation plus greater use of wind and solar power. But that is the extent of their program.

These groups show no awareness of new energy technologies or the harassment by our own government. Surely we could expect these people to at least push for freedom from harassment and possibly material support.

Prior to the 2000 presidential election, I contacted a number of major environmental organizations. I sent them some background information to establish the reality of new energy and the urgent need to move it forward to replace fossil fuels. I urged them to make a campaign issue of demanding laws to protect all those working on new energy projects from any form of harassment. In response to my initial phone calls, I was asked to send some documentation, which I did. However, in all cases those organizations showed no interest in following up.

I also contacted some of the minor political parties on this issue. I made a special point of contacting Winona La Duke, the environmentalist running mate of Ralph Nader, but could elicit no interest. In all my efforts the only response at all came from the John Hagelin presidential campaign and they said they were too busy during the campaign to address this issue.

I remain puzzled about what is going on with these supposedly environmental and progressive organizations.

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If any readers have made similar attempts, perhaps they can shed some light on this matter. Any comments would be appreciated.

Bertram Cohen
Poughkeepsie, New York

*Editor's Reply*: Your observations about major environmental organizations and political parties parallels our own experience with them over the past decade. The ignoring of cold fusion and new energy by virtually all environmental organizations is particularly egregious, especially since this is their *claimed* area of concern. One gets the distinct impression that these groups are in business mainly to hear themselves talk (or shout!), *not* to solve our energy and environmental problems. The head of one them, Amory Lovins of the Rocky Mountain Institute, which receives many millions of dollars in contributions each year, is widely covered by the media and bills himself as "Mr. Negawatt." I have concluded that it is best to ignore these people. They are hypocrites who are destined for the trash bin of technology history.—*EFM*

✍ ✍ ✍

**Warm Vortex**

As a subscriber to *New Energy News* I duly read, on page 5 of the August 2001 issue, the item by Bernd Nurnberger of Yokohama, Japan who drew attention to a report in a Japanese newspaper *Asahi Shimbun* dated July 28 2001, which had the title "Warm and Elevated Vortex in the Pacific Near Japan." It read:

> During the past 7 months, scientists have been observing a 400 km diameter vortex in the Pacific where water is 2-3 degrees warmer and the surface is 18 cm higher than normal. The vortex rotates clockwise at 1.8 km/h, moves West and has approached 100 km South of Okinawa, causing high tide 23 cm above normal. The vortex moved 150 km. Scientists have no explanation as to the cause of this phenomenon.
>
> According to the map inserted in the printed news page, the bubble has been tracked since January 3. It moved Northwest and on April 13 changed course to the West.

Now, of course, it needs little imagination to appreciate that here is some very unusual evidence pointing to an enormous influx of heat energy. Water expands if heated over a range above 4°C and so an enormous slow whirling whirlpool in the sea where ambient temperature is well above this critical value will, of necessity, be elevated above normal owing to that expansion if its temperature is also above normal. That heat energy must have a source, but that newspaper account says that "scientists have no explanation for the phenomenon."

Well, I can offer an explanation, and it is very relevant to the theme that is the subject of my article "Gravity and Its Thermal Anomaly," published in this issue of *Infinite Energy* on page 61. Readers interested in this explanation will find the topic discussed on my website (www.aspden.org) if they read the introduction of the book I am there drafting, entitled *The Physics of Creation*.

Harold Aspden
Southampton, England

✍ ✍ ✍

**Praise for Issue 39**

What a masterpiece your "Aether Science and Technology" issue (No. 39) was! I'm sixty-three in January and hope to live to see a demonstration of "free energy." The wind farm article by Bennett Daviss was much appreciated also. My wife and I are farmers/ranchers and live in the windiest place on planet Earth.

Don Glasscock
Roundup, Montana

✍ ✍ ✍

**The Reich Bombshell**

As a regular reader of *Infinite Energy* magazine (admittedly without a full understanding of the more technical articles), I was quite interested to hear Dr. Mallove on the Coast-to-Coast radio program on November 13.

Of particular interest to me was Dr. Mallove's discussion of aether energy and the work of the Correas based on the earlier research of Wilhelm Reich and his Orgone motor and Orgone Accumulator. As you are probably aware, Reich was imprisoned and had his published works burned and his equipment destroyed by the U.S. government in the 1950s.

Dr. Mallove is, as far as I am aware, the most credentialed scientist in this country (the Correas are Canadian) to publicly endorse his research. As recently as 1997 at a conference on the anniversary of Reich's birth, at least two of the presenting scientists did not want their names mentioned due to fear of possible repercussions on their scientific careers if it became known that they were interested in Reich's research. So it is clear that any general acceptance of his work would be a "bombshell" in science.

As a biologist, I am also quite interested in Reich's work in biogenesis (the Bions). The website www.orgone.org has a very convincing replication of his SAPA bion results using more modern equipment (*e.g.* the electron microscope) than Reich had.

Scott W. Didham
Quincy, Massachusetts

Aaron Ellsworth of Edinboro, Pennsylvania sent a change of address notice to us enclosed in this creative envelope design, in honor of our special Einstein issue (No. 38).

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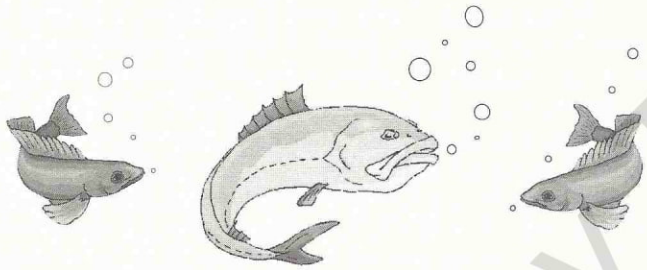
# Demonstrating Aether Energy

by Eugene F. Mallove, Sc.D.

If you were a deep-living fish, it might be tough to prove to your fellow fish that the world you were swimming in might hold, besides water, an invisible component indispensable to your existence, which you constantly move through and breathe in with the water that you swallow. Without a sensation of that pristine dissolved gas phase on its own, all your fellow fish would assert that the world was no more than interminable water, bounded with a sandy or rocky "bottom."

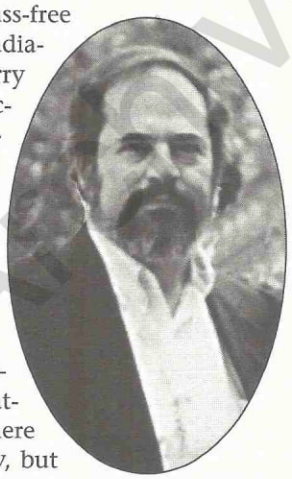
Debates would rage among the more philosophical fish about the "air" that might exist within (and perhaps *above*) the water, or about a hypothetical three-dimensional, infinite "empty space" that might comprise the greater universe. That "space," some fish would claim, might be even more fundamental than water and could be absolutely devoid of it—a barely conceivable idea for a fish! Virtually all physicist fish in this WaterWorld would be content to build their "theories of everything" on the hydrodynamics of water.



As fish are to air and space, so are human beings positioned with respect to the hypothetical *aether*. It has been difficult to fathom what lies right inside, around, and beneath our very noses. In critiquing the history of the aether and Einsteinian relativity, whose supporters dismissed that hypothetical light-conveying medium, the last three issues of *Infinite Energy* dealt with some profound errors at the foundation of modern physics.

Through the work of Dr. Paulo and Alexandra Correa, we learn that though the "luminiferous," static aether may be dead, thanks to the null result of the Michelson-Morley experiment and others that followed, a far different aether is very much alive. The Correas have communicated to me this apt summary of their experimentally-informed position on the aether:

"We actually feel quite strongly that Einstein made a forward step with his notion of a null-result having physical significance. We must defend Einstein against those who view the aether as merely the medium for the propagation of light. We dispute the nature of *what* propagates in Space—since it is not light, it is a different form of radiation. But the aether is not there to propagate light, any more than it is a medium for light. Space is not a container; Space is contained by the very energy that propagates through it. What, so to speak, propagates in the vacuum (in the phenomenological absence of matter) is mass-free ambipolar [ambi-electric charge] radiation; this radiation happens to carry the excitation for local light production, but only the presence of matter reveals this excitation by the local production of light. Einstein must be at once negated, double-negated and affirmed. The medium itself is not the conveyor of light. All theories of the static aether are thereby proven wrong. We are with Einstein at that departure. So Einstein did dismiss the static aether that functioned as a mere conveyor of light, not prematurely, but in the nick of time."



That may well be true, but it is certainly most unfortunate that the dismissal of the original "luminiferous" conception of aether led to the denial of *any* other kind of aether. *Infinite Energy* readers have learned from the Correas of the immense opportunity that was lost when Albert Einstein botched the conclusion of the temperature measurement experiment brought to him by Wilhelm Reich in January 1941 (see *IE* No. 37, "The Reproducible Thermal Anomaly of the Reich-Einstein Experiment Under Limit Conditions," p. 12). This was a window to new aether physics. Now the Correas have magnified and demonstrated that thermal anomaly with what might be thought of as an "aether transducer."

A small, precision Stirling heat engine, derived from what Scotsman Robert Stirling invented in 1816, runs quite well—apparently on this transduced aether energy. People such as Dean Kamen (of "IT," "Ginger," and now "Segway" fame) have been trying to perfect Stirling engines for power generation in developing countries and elsewhere. Before going much further they should look into the infinite energy source staring them in the face.

Yes, the cover story of this issue depicts schematically the Correas' experimental apparatus. Their article, "A Modified Orgone Accumulator (HYBORAC) as a Drive for a Low Delta-T Stirling Engine," makes the case that the locally experienced aether energy is sourced, in part, in the Sun. A follow-on article by the Correas on this aether demonstration device, which will appear in the next issue of *Infinite Energy*, describes how they have made the same Stirling engine operate through almost seven hours of nighttime darkness! Those skeptics who would try to pass off this issue's discussion, and the included controls, as "merely a demonstration of ordinary solar energy and its storage," will be more hard-pressed to explain how a Stirling engine can work so well at nighttime with no evident fuel source—

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preserving an adequate temperature difference between its bottom (hot) and top (cold) plates.

It is unlikely that the demonstration of aether energy described in this and the follow-on paper will convince skeptics, as the Correas themselves are first to admit. They write, "By itself, this irrefutable demonstration of free energy is not an analytical proof of the existence of either orgone energy or latent heat. [Ed. note: 'Orgone energy' was W. Reich's term and 'latent heat' is a special term used by the Correas to characterize one component of the aether (see elaboration in text below).] One can already hear the objections of mechanistic-minded scientists— 'all you have shown is that you can drive a Stirling from solar radiation.' That is right. But why the contempt or incredulity? Because what they mean is that all we have succeeded in doing with the preceding was merely to show that a matte black box, properly constructed, can maximize the influx of solar electromagnetic radiation and convert it into heat. Here, however, is precisely where they are proven wrong by our own demonstration that the main modes of blackbody absorption for BORACs [Black Orgone Accumulators], or the measured rate of heat flow, cannot account for the heat radiated and trapped in these devices, even when they are 'directly exposed to the Sun.'" They refer to their website monograph, AS2-05, "The Thermal Anomaly in ORACs and the Reich-Einstein Experiment: Implications for Blackbody Theory." (Available on www.aetherometry.com.) One of the most stark conclusions of the Correas' theory is sure to stretch the limits of the most open-minded of physicists. Their challenge:

"Aetherometry demonstrates that what traverses Space is not transverse electromagnetic radiation (and certainly not sensible heat), but longitudinal ambipolar electromagnetic radiation emitted from the Sun. All that electromagnetic radiation consists of is a local production of photons (for those who care to listen: aether energy is not composed of photons, actual or virtual)."

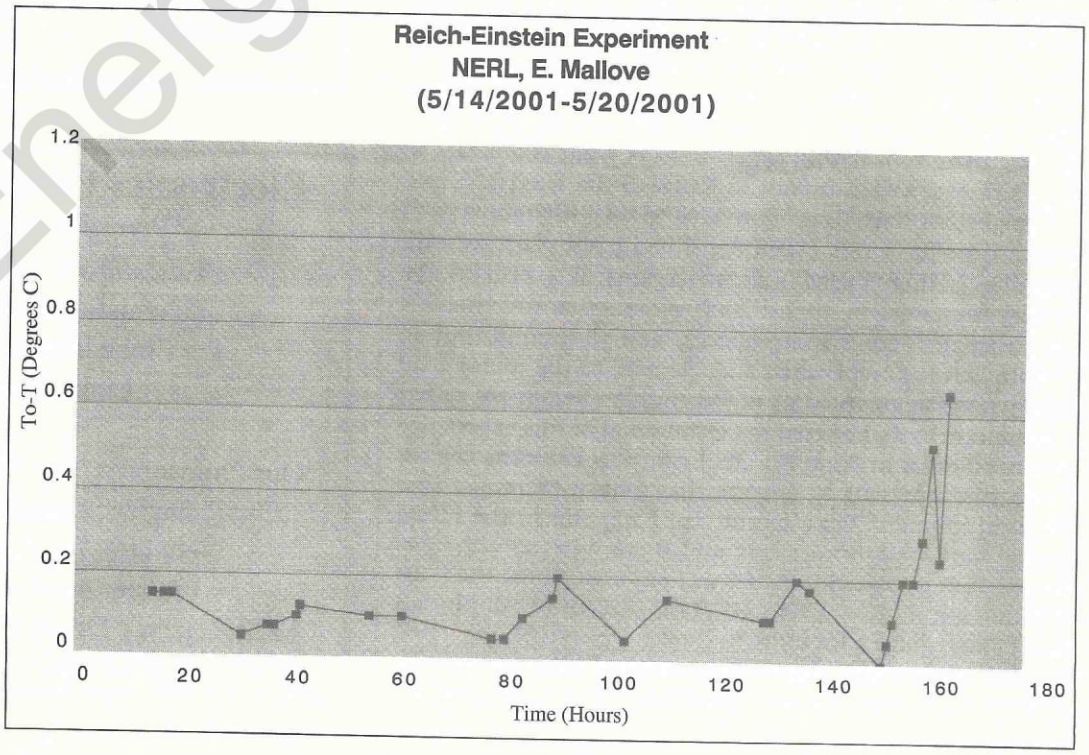
This formulation suggests that modern physics is not just wrong, it is profoundly wrong—catastrophically wrong about even the most fundamental questions of existence, such as: 1) Is there an energetic aether? and 2) What is the nature of light? To be sure, certain mainstream (and not-so-mainstream) physicists are beginning to use the term "aether" in a revisionist sense, but only with abracadabra incantations of "zero point energy" and quantum mechanics (see the comment in this issue about a recent cover story in *New Scientist*, p. 57), or what Einstein said about "aether" in his later years. That *cannot* be the aether physics that presumptively runs this Stirling engine. To begin to understand that new physics requires reading at least the Correa monograph AS2-05.

Concerning the "latent heat" alluded to above, the Correas attribute to it precisely the same properties that meteorologists do, or that thermodynamicists attribute to the intrinsic energy of a molecule, except that they view the complex of manifestations of latent heat as a non-electric form of radiant aether energy that exists either bound to mass in an "anti-gravitokinetic" relation or in massfree form. This massfree aspect may have profound cosmological implications.

Now, if the HYBORAC Stirling engine experiments fail to move you to study aether physics, and if you want to see for yourself how profoundly misdirected modern physics may be, do this, as I did last spring. Carry out a minimalist Reich-Einstein experiment. If nothing else, it's a quick way to prove that you are a better experimentalist than *"gedanken* experiment Albert" ever was:

Get yourself at least two identical batch-calibrated mercury thermometers (range 0°C to 50°C, with 0.05°C divisions). Confirm that the thermometers read the same value within say ±0.025°C, by having their bulbs touching as the two thermometers rest side-by-side, suspended in air or lying on a uniform surface. I recommend using the exemplary services of the Miller & Weber, Inc. precision thermometer company (1637 George Street, Ridgewood, NY 11385, Ph: 718-821-7110). The thermometers I used were designated "T-3400s/50C1"and were 24 inches long, total immersion, yellow back, and mercury filled.

Next, have your local sheet metal fabricator make you a galvanized metal cubical container (say 8" on edge). This is your Faraday cage, which can be made air tight if you wish, but that is not very important. Then in a darkened room, perhaps a section of a cool basement and distant from walls or active heating devices, conduct a week-long experiment—or longer if you have the patience. Hang one thermometer from the ceiling, with nylon cord tied or taped to its top, such that the mercury bulb is about at mid-room height (*e.g.* three feet from the floor). Affix the other thermometer just over the center of the top of the metal cube. Begin by taping (with clear tape) a 2"

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length of 0.5" PVC plastic pipe to the metal surface—orienting the tube vertically. Use black electrical tape wrapped around the thermometer just above its mercury bulb, to make a support plug for the thermometer. When the thermometer is inserted into the vertical PVC tube (or more conveniently perhaps into a snap-on PVC union coupling), the bottom of the thermometer bulb should hover 1 to 2 centimeters above the top surface of the metal cube Faraday cage.

Now you are ready to hang this contraption from the ceiling with four tough strands of nylon fishline (remember, you are *not* a dumb fish—you are *looking* for evidence of the aether!) that can support the cube from its bottom like a net. The four cords should come together above the center of the Faraday cage; the top surface of the cage should be level with the horizontal plane; and the mercury bulb of the thermometer should be at the same height as the nearby air-suspended thermometer. The Faraday cage should be reasonably close to the air-suspended thermometer—say one to two feet away.

Now, everyone should agree that in the relatively still air of a darkened room, after the equipment has thermally equilibrated, one expects that two nearby mercury thermometers, with or without a Faraday cage under one of them, should read the same. *Not so!* I found a consistent, easily measured elevation of the temperature read by the Faraday cage thermometer over the air-suspended thermometer. The two thermometers differed—ranging from about 0.05°C to over 0.6°C, with an average elevation of the Faraday thermometer between 0.1 and 0.2 °C. See the accompanying graph of this data.

I performed several other experiments with this apparatus, but these are too involved to describe at this time. There is an apparent diurnal variation in To-T, which critics might try to pass off as some evidence of blackbody absorption differences, etc. that might be affecting the measurement. On that theory, one might have expected some negative To-T values, but there were none during that period. For now, I defer to the experts in performing the Reich-Einstein experiment repetition, the Correas, in their several references quoted earlier. In particular, their experiments with both white and black ORACs (enhanced Faraday cages) out of doors and in the shade show convincingly that some other factor is heating the interior of the Faraday cages and the heat is then percolating to and through the top. If this experiment is what it appears to be, as they say, "we are not in Kansas"—far from it.

I might not have been motivated to take thermometer in hand to perform this experiment, had I not observed self-running (aether-"fueled") *electric* motors at a visit to the Correa laboratory in August 2000, motors that were hooked up to small orgone accumulators, and to ground, but to nothing else—except when a single wire to the motor held in my hand augmented its power (human beings are aether transducers too!). I offered my testimonial of this experience in my editorial in Issue No. 39. I can now erase the caveat, "I do not represent to anyone that I have examined [the motor's] innards." On a recent visit I was shown the inside of the motor electronics box and there were *no active elements*, such as batteries. As far as I am concerned, these *are* self-running motors, aether energy is real, and both physics and biology have a lot more to learn.

I also saw cup-size electronics (with no active element or power source) that charged a capacitor (or re-chargeable battery) overnight. I saw an "aether field meter" (again with no power source) that produces a significant voltage according to the presence, distance, and condition of an approaching human being several meters away. Not to forget the Stirling motor demonstration, which is also a potentially utilitarian device—an augmented form of solar power.

Perhaps some of the devices (not the aether motors), which the Correas are considering licensing as scientific kits, may encourage others to study this exceptional work. I very much hope so. ❑❑❑


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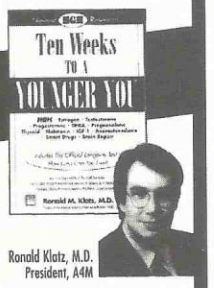


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# Landmark Cold Fusion Patent Issued

## — An Introduction by Eugene F. Mallove —

On June 19, 2001, the U.S. Patent and Trademark Office (USPTO) issued U.S. Patent #6,248,221 for "Electrolysis Apparatus and Electrodes and Electrode Material Therefor," to Randolph R. Davis and Thomas F. McGraw. The context of the patent, its claims, and the numerous references to the mainstream cold fusion/low-energy nuclear reaction literature cited by the inventors leave no doubt that this is, indeed, a patent for a form of cold fusion technology. Thus, this is a landmark patent. The original Fleischmann-Pons paper of 1989 and all that followed from it are properly cited. Approval of the patent was through an art group within the USPTO that somehow managed to escape the well-known forces of opposition.

We are delighted with this return to sanity by at least one part of the USPTO! Without intending to detract one bit from the accomplishment of the present inventors, we only wish that the USPTO had dealt fairly with the many other individuals who should have been awarded patents for their cold fusion applications—especially Drs. Fleischmann and Pons.

I discussed the R&D behind the patent with co-inventor Davis, whom I have known since the early 1990s, though I was unaware of his involvement with this work. Randy Davis was tight-lipped about the current performance of the prototype "gas phase electrolytic systems" covered by the new patent, but he was kind enough to send us the following note for publication:

> It was good speaking with you several days ago about the recently issued patent. The paper, "Critical Factors in Transitioning from Fuel Cells to Cold Fusion Technology," lays out important aspects of systems engineering from a general perspective. This paper was presented in 1998 at the 33rd Intersociety Engineering Conference on Energy Conversion. Due to evidence from the experiments of other researchers that reactions occur, the objective is to engineer various parts of hardware for 10 kW systems. The electronic control circuit has recently been improved, and attempts are being made to improve the reaction material and the overall system engineering.
>
> The "critical factors" paper indicates that breakeven for the system would mean getting somewhat more than 50 watts. As for many other similar projects, details continue to be highly proprietary, to include not only the direction of the technical work, but also information that would permit the direction of the work and progress to be determined.
>
> Finally, it is hoped that through such advancements, others performing difficult scientific investigations will be encouraged to continue their work.

Davis also gave us permission to reprint a paper that he and his co-inventor gave at that technical conference in August 1998, "Critical Factors in Transitioning from Fuel Cell to Cold Fusion Technology." It is a good general overview of the parameters and design factors of particular importance in developing cold fusion technology. The group foresees 10 kW electricity generating units for home use, but I believe that they have overestimated the ultimate cost of such systems to the mass market. I am confident that electricity costs from cold fusion systems will be far below one-cent per kilowatt-hour.

The patent, for which we provide only the abstract and a few introductory particulars, relies on a cylindrical geometry reaction vessel in which "nanocrystalline particles" help facilitate hydrogen-based reactions from gas that permeates the reactor components. They evidently require or envision a significant level of electronic process control to stabilize the reactions. ❑❑❑

# Critical Factors in Transitioning from Fuel Cell to Cold Fusion Technology

Thomas F. McGraw* and Randolph R. Davis**

*This paper was presented at the American Nuclear Society's 33rd Intersociety Engineering Conference on Energy Conversion (Colorado Springs, Colorado, August 2-6, 1998) and is reprinted with permission of the American Nuclear Society and the authors.* *Copyright 1998 by the American Nuclear Society, La Grange Park, Illinois.*

**Abstract**

The fuel cell industry possesses much of the required manufacturing equipment and knowledge-base (*e.g.*, proton conduction and hydrogen safety) necessary to develop cold fusion systems. Key factors in making a transition to cold fusion technology are discussed. Loading of reaction material can be provided by electrolytic charging and high gas overpressure. Effective pressures over 10,000 atmospheres are required in cold fusion systems, giving a loading of H/M = 1; and a combination of loading methods is highly desirable. Systems must be designed to provide continuous flow of hydrogen ions ($\approx 10^{17}$/sec for ten kilowatts), with an input power source of 50 watts (est.). Cold fusion experiments have shown that helium is formed during the reaction, and physical changes occur in the reaction material. These revelations impact design and operation of cold fusion systems, as the reaction material must be replaced periodically, while the systems must maintain integrity during operation. Safety and cost are also highly important considerations.



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## I. Introduction

Hydrogen in metals is a historically well-studied subject because of interest in embrittlement of metals and their failure mechanisms. Recent interest has been related to development of new devices, such as improved proton conduction fuel cells and hydrogen generators. R&D organizations working on fuel cells in particular already possess much of the knowledge-base and manufacturing know-how necessary to transition into cold fusion technology.

The benefit of cold fusion derives from the interaction between chemical and nuclear forces within a reaction material; energy appears to be released by nuclear fission, nuclear fusion, a combination of fusion and fission, or fusion and fission operating separately. Many scientists, engineers, and investors have given cold fusion serious attention since Pons and Fleischmann discovered it in the mid-to-late 1980s.[1] The New Energy Partners venture capital firm, for example, has supported companies with working prototypes, and several prototypes are being tested to determine heat output levels and reaction rates.[2] Approximately 1500 papers from technical journals and conferences have reported some degree of replication of the cold fusion effect (800 in U.S.); 300 related patent applications have been developed in the U.S.; and 100 patents have been granted in Japan.[3]

## II. Proton Conduction and Loading

Achievement of high concentrations of hydrogen isotopes (*i.e.*, deuterium, protium, or both) within metal reaction material (Figure 1) is considered to be paramount in rendering operable cold fusion systems.[4] Concentrations close to 1 ($H/M \approx 1$) have been shown to be possible for powdered palladium metal when the externally applied pressure is 10-15 kbar (25°C). This level of loading is difficult to attain, first, because the number of metal atoms (M) is a large quantity. Other metals, such as nickel, require higher pressures to achieve this degree of loading. Still higher pressures are required at higher temperatures.

In order to design operable systems, it is absolutely necessary to invest effort in understanding the work by M. Enyo at Hokkaido University regarding the several types of disassociation mechanisms responsible for producing hydrogen atoms as intermediate species. Loading is described in terms of chemical potentials discussed in physical chemistry and thermodynamics. Enyo in the mid-1970s made an assumption that rates for all reaction steps may be of the same magnitude, rather than imposing a constraint that there is a single rate-determining step. From this, he derived equations describing variation of activity of the intermediate hydrogen species with electric overpotential, $\eta$ ($\eta = -\Delta\mu/F$, where $\mu$ is chemical potential and F is Faraday's constant). Enyo showed that the amount of loading varies with overpotential. Indeed, the equivalence between hydrogen gas pressure and electrical overpotential means that a change in activity of the intermediate species produced by the overpotential is equal in magnitude to that produced when pressure is increased from its equilibrium value.[5]

Enyo went even further to show that, due to competing disassociation mechanisms, greater overpotential would be required to produce a given loading than that calculated by the generally-used Nernst equation. His data from the early 1980s may be used as a guide in determining best overpotential levels to use. He demonstrated reasons for previously measured values of $H/M = 0.7$ in the bulk of palladium at 1 atm, and for the increase in loading obtained as pressure or overpotential is increased. After the quantity of hydrogen to metal (H/M) is up in the vicinity around 0.9-1, very large increases in external pressure are required for small increases in concentration.[6,7]

Two other effects make the required level of loading difficult to attain. Electrical resistance of loaded metals varies as hydrogen concentration increases. Compensation must be provided for the variation in electrical resistance by means of a suitably-sized power supply. Secondly, hydrogen concentration, and consequently, reaction rate will not be uniform across the volume of reaction material *even* when steady state conditions are reached, but will be localized into a thin region. The localized concentration of hydrogen will move about in response to changes from the steady state. This is demonstrated in equations of hydrogen flux through the reaction material by the sum of a drift term due to electric field and a diffusive term caused by temperature gradient. The localization and movement of hydrogen in the reaction material have important consequences. As a result, a long electrode with a large surface area is much better than a thick one. And, there will always be continuous leakage of hydrogen out of the system. The amount of loading achieved will depend to a large extent on how well leakage can be prevented. The physics behind these considerations is discussed in *Hydrogen in Metals II, Application Oriented Properties*, published in 1978.[8]

Due to these difficulties in obtaining high loading, cold fusion systems should be designed to be loaded via a combination of physical pressure and electric field. Moderate gas pressure may be obtained by bottled gases. Notable efforts have been conducted at the Los Alamos National Laboratory in high pressure charging.[9] If the objective is to produce 500 watts to 50 kilowatts continuously, the flow rate should be about $10^{17}$ per second. A simple proton conduction model that takes into account the work required to transfer this number of charges into the reaction material, plus additional current required as the reaction material changes, indicates that the input power source should be capable of providing 50 watts.

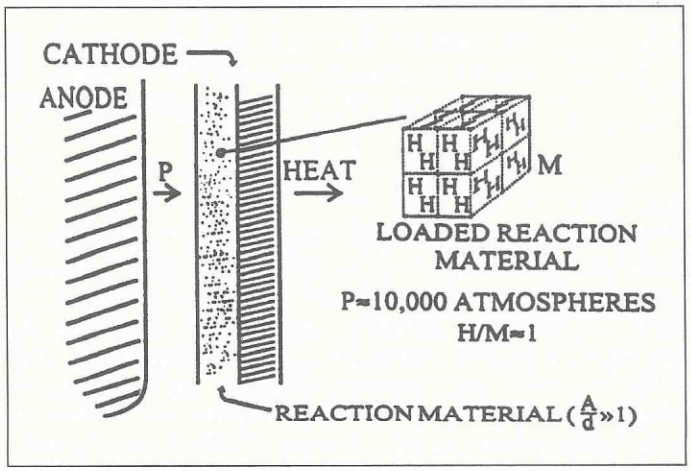


**Figure 1.** Typical electrode configuration.



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Specifically, 10 watts are required to move the positive charge into the reaction material, and several times this is required against a phantom current produced as the reaction proceeds. A 2-to-1 design margin could be provided by a 100 watt d.c. power supply. A sense of the high efficiency of cold fusion systems can be obtained from this information. In comparison, future hydrogen fuel cells are projected to have an efficiency of 0.70 for converting heat to electricity ($\varepsilon = 0.70$), *e.g.*, 10 kilowatts of electricity from 14 kilowatts (heat) input.

## III. Maintenance

Reaction material will become deactivated during operation by microscopic high temperature fracture, melting and material segregation, by hydride formation, and by buildup of reaction products. Experimental data show that helium is produced as a result of cold fusion reactions. Other chemical elements that originally were not detected in the starting reaction material also appear to form. Methods must, therefore, be developed to collect helium gas produced during operation of cold fusion systems and to replace spent reaction material periodically. As the systems must maintain integrity during operation, development of these methods is a key challenge area.

Collection volumes and replacement intervals can be roughly determined from quantities of helium and other elements measured in cold fusion research. The most notable efforts to quantify helium were conducted by M. Miles and associates at the Naval Air Warfare Center, China Lake and by Y. Arata at Osaka University.[10,11] Additionally, mechanisms have been determined for forming helium bubbles in metal reaction material and their subsequent release.[12] China Lake's data indicate that helium is produced at a rate of $10^{11}$-$10^{12}$ atoms per second per watt, and is commensurate with heat measured. Arata's data confirm that helium is produced. Due to the small quantities of helium, collection bottles in operating systems can be small and easily handled.

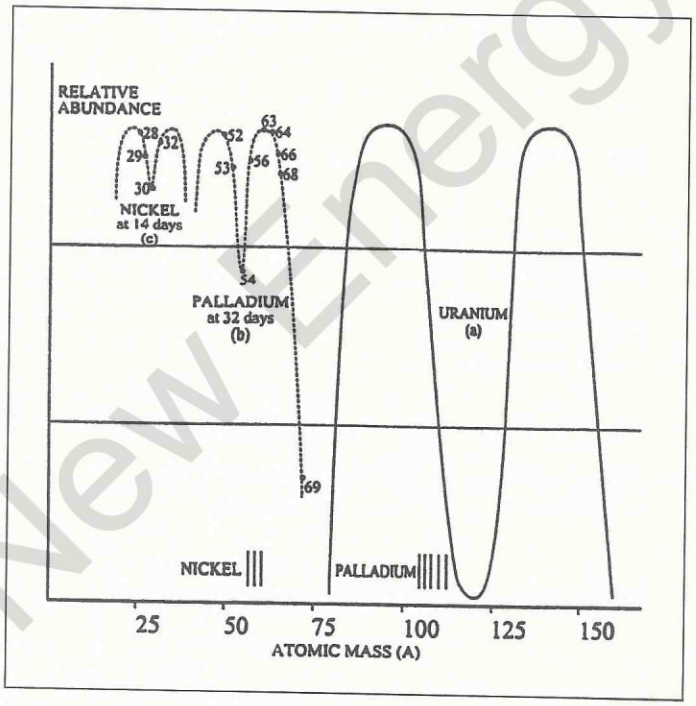


**Figure 2.** Relative quantities of species formed in electrodes.

Chemical elements in spent electrodes were measured by a number of methods, such as energy dispersive X-ray analysis and secondary ion mass spectroscopy. While strong residual radiation typical of nuclear power plant fuel is not present, some mild type of radiation has been observed.[13] Relative quantities of elements in the electrodes can begin to be estimated from results obtained by T. Mizuno at Hokkaido University for palladium and G. Miley at Urbana for nickel.[14,15] The uranium-235 fission yield curve (a) of Figure 2 was plotted to illustrate some of their results. Parts of Mizuno's data (b) indicate that 0.12% Cr-52, 0.6% Cr-53, 0.009% Mn-54, 0.06% Fe-56, 0.02% Fe-57, 0.12% Cu-63, 0.11% Zn-64, 0.08% Zn-66, 0.06% Zn-68, and 0.0005% Ga-69 were measured relative to 100% palladium. The largest value (Cu-63) was assumed to be comparable to the value for the peak of the uranium fission yield curve and the value for Mn-54 was assumed to represent a minimum at the midpoint of data, as this isotope has a mass that is half of the mass of Pd-108. Parts of Miley's data (c) are plotted by assuming that they surround a midpoint at A=29-30, half of the mass of Ni-58, 59. Insufficient data and resolution in the measurements prevent definitive conclusions to be drawn concerning reaction processes. It is interesting to note that hypothetical palladium and nickel "fission yield curves" appear to have the same width-to-midpoint ratio as the uranium fission yield curve. Mizuno and Miley reported data for many new species that are not shown here, many of which have masses close to palladium and nickel reaction material. Benefits of reprocessing the reaction material may be estimated from these types of data.

## IV. Safety

Safety is of primary concern in cold fusion technology, due to the potential for hydrogen and hydrocarbon reactions and high pressure explosions.[16] Stringent precautions must be applied in system and experimental design. Safety barriers between the cold fusion reactor and experimenter are depicted in Figure 3.[17] Operational designs should ensure that systems will be kept sealed as much as possible to prevent entry of oxygen and hydrocarbons. In this experimental arrangement, the many tubes and valves have the purpose of keeping the system sealed after reaction material is installed and the reactor connected. The chance for unloading of hydrogen in the reaction material is reduced by maintaining voltage across the system with an uninterruptible power supply. Experimenters should comply with American National Standards Institute (ANSI) standards for hydrogen and oxygen containing components. Components must be able to contain, or otherwise respond to, abnormally high internal pressures that may develop during operation. Particular care should be given to joints, welds, and strength variations between components. Protective jackets can be utilized in operational systems to ensure that malfunctions do not damage outside areas; in the experimental layout, this is provided by a separate enclosure for the reactor. Protective jackets should be designed to prevent maintenance by untrained persons. Pressure sensors and pressure relief devices can be used to detect and respond to unusually high pressure conditions. The possibility of very rapid

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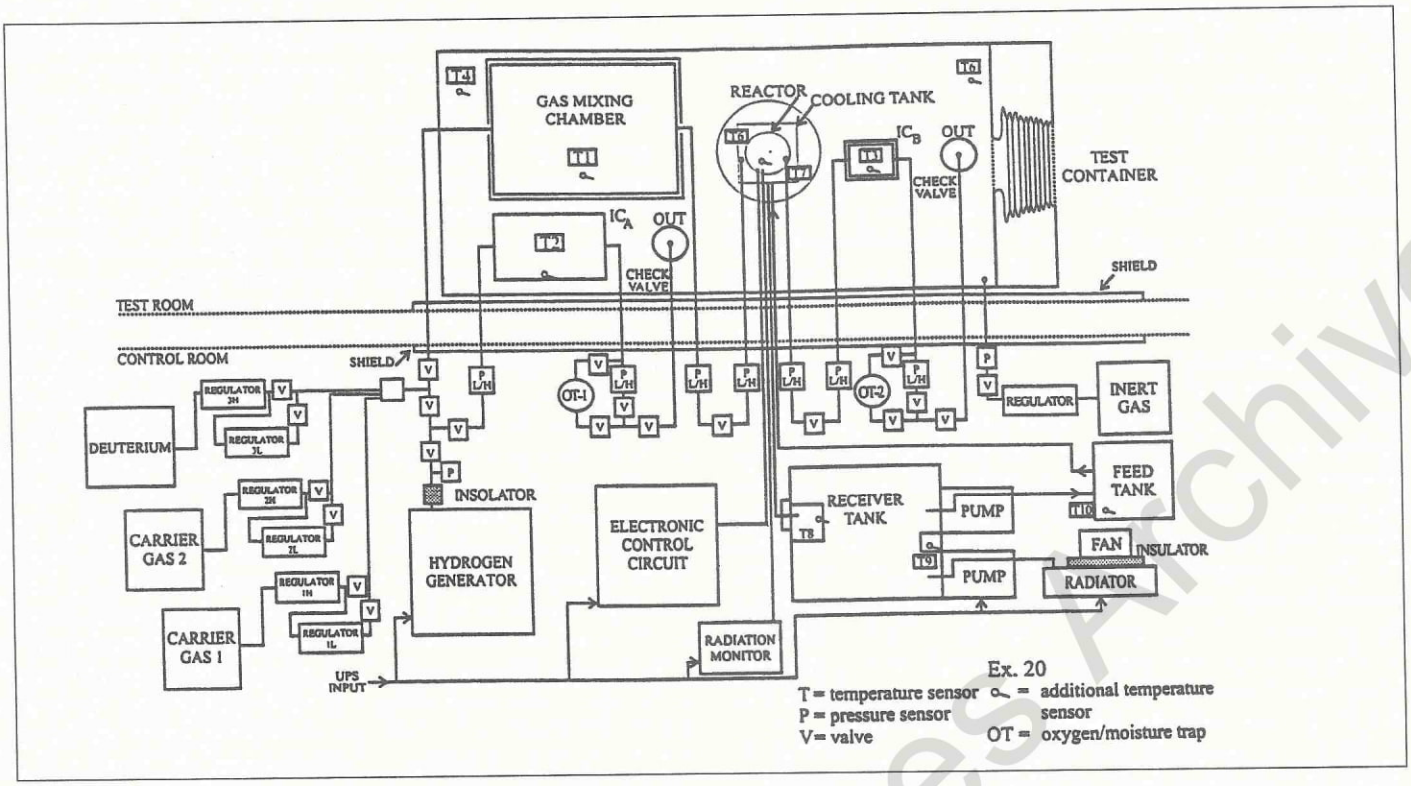


**Figure 3.** Experimental design with safety consideration.

unloading also implies the need for stringent safety precautions when handling spent reaction material. Designs should ensure that spent material can be safely removed by a maintenance technician, transported to a reprocessing center, remanufactured into new reaction material, and that the new reaction material could be safely installed.

## V. Cost Factors

Cold fusion technology may permit energy independence for the individual homeowner and nation-states; and, development of kilowatt systems could be an important advancement in national and international security. Life cycle costs for individual, homeowner-type 10 kW units can be estimated and compared to the cost of electricity produced by oil and nuclear power plants. Estimates of natural resources used may also be developed. As indicated in Figure 4, provisioning and maintenance over long use periods should be included in cost estimates.

The authors estimate that the system will cost $30k over thirty years, including reactor, electronic controller, installation, and replacement parts. Gas service should cost $7-8k and a service contract about $10k. Replacement reaction material is estimated to be $20-30k. The total of these amounts results in less than 3¢/kWH for the cost of electricity, which compares very favorably with the least cost of electricity from the power grid. Additionally, waste heat from the unit would be provided at *no cost*. Exemption from any future global pollution tax would certainly be expected, as cold fusion systems should contribute significantly to conserving national and international resources. Only a small fraction of the $10^{40}$ hydrogen isotope atoms available from sea water would be used, even if all 800 million earth households were provided 10 kW units. Spent gases and reaction material could be collected locally and reprocessed by new commercial enterprises to provide additional benefits.

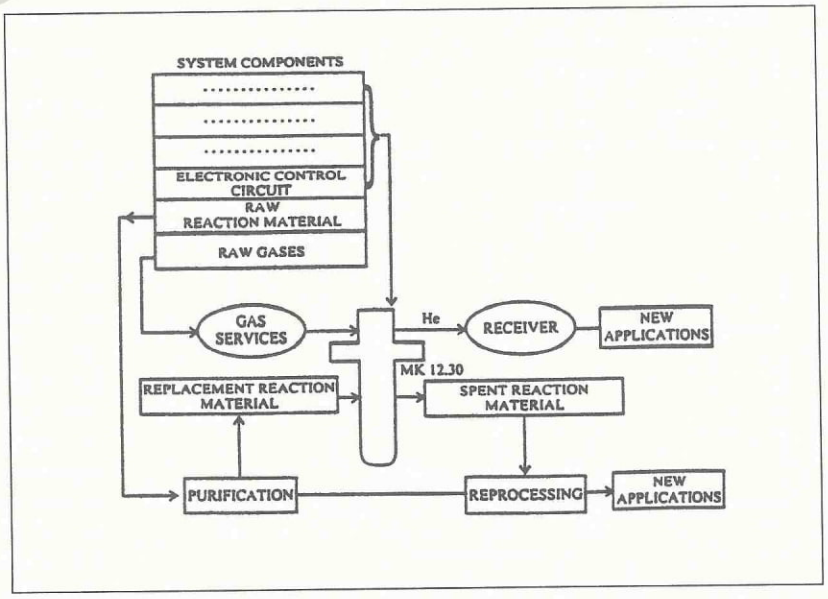


**Figure 4.** Component/product flow/cost estimation diagram.

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"Electrolysis Apparatus and Electrodes and Electrode Material Therefor"—
United States Patent No. US 6,248,221 B1

**Date of Patent:** June 19, 2001

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**Filed:** June 1, 1999

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Induced Nuclear Fusion of Deuterium," submitted to the *Journal of Electroanalytical Chemistry*, March 11, 1989.

• [Editor's Note: Twenty-four other references are not noted here. The Pons-Fleischmann reference was noted later on in the list, but we felt it was necessary to include it here.]

| | |
|---|---|
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**Abstract**

An improved electrolysis system includes a cylindrical anode, a cylindrical cathode, a cathode material including nanocrystalline particles, and an insulator disposed between the anode and the cathode material to prevent contact between the anode and the cathode material.


**Electrolysis Apparatus and Electrodes and Electrode Material Therefor**

This Appln claims the benefit of Provisional No. 60/009, 257, filed Dec. 26, 1995, and is a division of Ser. No. 08/779,957 filed Dec. 23, 1996, abandoned.

BACKGROUND OF THE INVENTION

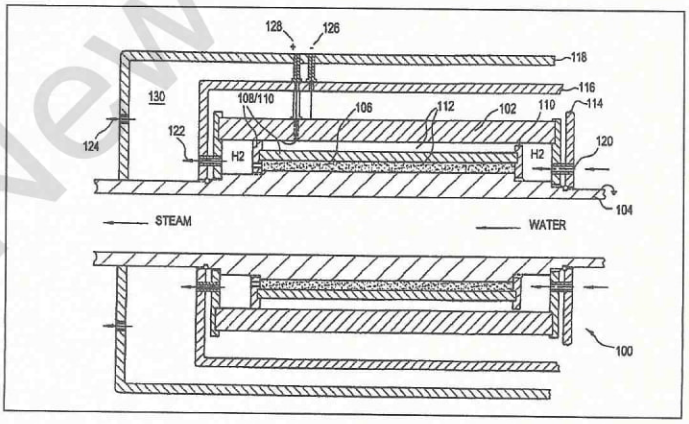
1. Field of the Invention

The present invention relates generally to electrolysis systems. More specifically, the present invention relates to improved materials, structures, and methods for improving electrolysis systems.

2. Description of the Related Art

Since 1989, scientists have demonstrated that liquid and gaseous electrolysis processes, though not yet completely understood, may be able to address future heating and electrical power requirements. For example, it has been readily demonstrated that electrolysis of many fluids results in heat generation that can be employed for other purposes, *e.g.*, heating or generation of electricity.

A growing need has developed for compact, reliable, rugged, and self-contained power sources providing heat and/or electricity in applications such as mobile vehicles, trailers, and equipment support units. There is a concurrent need for reliable, rugged, and self-contained power sources providing heat and/or electricity for larger stationary power requirements. A sense of urgency for such new power sources has resulted from the realization that fossil fuels are in limited supply. It will be appreciated that nuclear fission power plants are not an acceptable alternative due to the dangers associated with uncontrolled releases of fission products and the enormous environmental and political problems associated with waste disposal.




Early attempts to develop the needed energy production apparatus focused on energy production using nuclear batteries. See, for example, U.S. Pat. Nos. 3,290,522; 3,409,820, and 4,835,433, which patents are incorporated herein by reference for all purposes. A radiation source was required, and radiation from this source which was absorbed in a potential barrier, *e.g.*, p-n-p junction or metal-semiconductor contact, gave rise to electron-hole pairs that flowed as electricity due to the beta voltaic or Volta effect. Efficiencies on the order of about 25% were demonstrated.

In their now famous (or infamous) paper, Pons and Fleischmarm reported excess heat in heavy water, palladium apparatus. See Martin Fleischmann and Stanley Pons, "Electrochemically Induced Nuclear Fusion of Deuterium," submitted to the *Journal of Electroanalytical Chemistry*, Mar. 11, 1989. Due to the amount of heat produced per unit volume of cathode material, the energy measured in these types of apparatus has generally been considered to be from a nuclear process. Measurements of helium and tritium produced have given credibility to methods where heat is produced.

Recently, engineered devices based upon these results have been built with the objective of investigating the production of heat and by-products over extended periods of time. For example, U.S. Pat. Nos. 5,273,635 and 5,318,675, which patents are incorporated herein for all purposes, as well as Great Britain Patent No. 2 231 195, EP 0 568 118, and W095/20816 have been granted for or described such devices, respectively. As a result, problems with the state of the art of methods of liquid and gaseous electrolysis have begun to be addressed by investigators with improved consistency. It will also be appreciated that problems associated with such systems include: hydrogen recombination with oxygen, with the potential for explosion; the relatively slow loading of hydrogen into cathodes; inefficient designs; and, the potential dangers of loaded, pressurized bulk material.

Further developments of and improvements in energy power systems utilizing liquid, plasma or gaseous, *i.e.*, fluid, electrolysis techniques are severely hampered by a lack of:

(1) improved cathode materials;
(2) rugged yet porous reaction vessels;
(3) control circuitry designed to promote and control various aspects of long duration cathode loading and electrolytic cell operation; and
(4) an electronic control circuit to promote and control electric currents produced by nuclear processes similar to those developed by nuclear batteries.

SUMMARY OF THE INVENTION

Based on the above and foregoing, it can be appreciated that there presently exists a need in the art for an improved electrolysis system which overcomes the above-described deficiencies in the pertinent art. The present invention was motivated by a desire to overcome the drawbacks and shortcomings of the presently available technology, and thereby fulfill this need in the art.

An object of the present invention is to provide an electrolysis apparatus which preferably utilizes an improved cathode material. According to one aspect of the present invention, nanocrystalline material made by spray conversion processing advantageously can be used for the cathode reaction material.

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Another object of the present invention is to provide an improved reaction vessel for an electrolysis apparatus. According to another aspect of the present invention, an improved reaction vessel advantageously can be constructed for porous, rugged, ceramic matrix composites.

Yet another object of the present invention is to provide an improved electronic control circuit for the improved electrolysis systems which is specifically adapted to control the physical processes associated with long duration electrolysis operations.

According to another aspect of the present invention, the inventive electrolysis apparatus applies to fluid, *e.g.*, liquid, gas, or plasma, electrolysis systems having a cylindrical configuration which utilizes the above-mentioned improved cathode material, porous reaction vessel and application specific electrical control system. It should be mentioned that a cylindrical reaction vessel takes advantage of radial electric fields extending between its walls, thus promoting hydrogen transport in the direction of the reaction material.

These and other objects, features, and advantages according to the present invention are provided by a cathode comprising a plurality of nanocrystalline particles formed by spray conversion processing. According to one aspect of the present invention, the nanocrystalline particles are formed from a single element selected from the group consisting of Fe, Ni, Cu, Mo, Cr, Co, Mg, Ag, and W. According to another aspect of the present invention, the nanocrystalline particles are formed from elements selected from the group consisting of Fe, Ni, Cu, Mo, Cr, Co, Mg, Ag, and W.

These and other objects, features, and advantages according to the present invention are provided by an electrolysis apparatus, which includes a cylindrical anode, a cylindrical cathode, a cathode material including nanocrystalline particles, and an insulator disposed between the anode and the cathode material to prevent contact between the anode and the cathode material.

These and other objects, features, and advantages according to the present invention are provided by an electrolysis apparatus, including a cylindrical anode, a cylindrical cathode, and a cylindrical, consolidated cathode material including nanocrystalline particles, wherein all of the cylindrical anode, the cylindrical cathode, and the cylindrical, consolidated cathode material are disposed coaxially.

Moreover, the electrolysis apparatus preferably includes a control system for controlling the potential between the anode and the cathode. Advantageously, the control system, which can be employed in a fluid electrolysis apparatus, includes a programmable controller, a power supply, monitoring devices operatively coupled to the programmable controller, and electronic regulators controlled by the programmable controller and receiving power from the power supply for providing electric current and voltage so as to facilitate movement of hydrogen into a reaction volume disposed between the anode and the cathode.

According to one aspect of the present invention, the control system monitors and controls variations in current in the reaction volume under changing temperature, pressure and reaction conditions. According to another aspect of the present invention, the control system detects and equilibrates induced currents across the cathode material produced by reaction products. According to yet another aspect of the present invention, the control system equilibrates induced currents across the reaction volume produced by at least one of positions and electron capture. ❑❑❑


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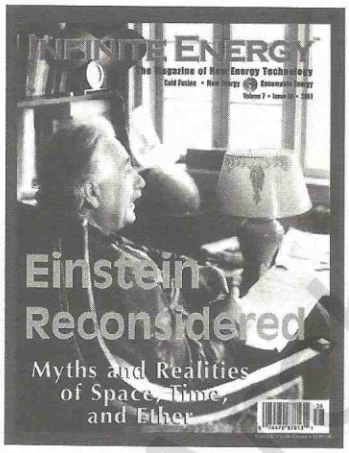


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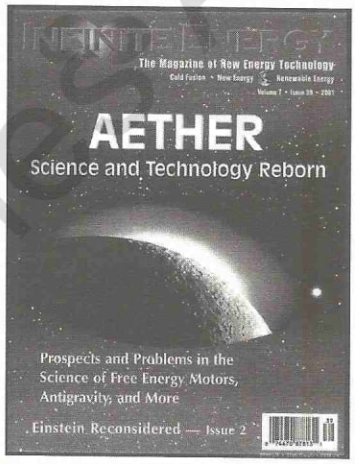


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# Report on the Third Meeting of the Japan Cold Fusion Research Society (JCF3)

Jed Rothwell

Roughly fifty people (the same as last year) attended the third JCF conference held on October 25-26 at Yokohama National University.[1] Last year and again this year the only non-Japanese participants were A. Arapi, who is studying at Iwate University (see title JCF3-13, below), Francesco Celani (JCF3-5) of the Italian National Physics Laboratory, and me. Mitsubishi again presented the most technically impressive results. Celani described some exciting and unexpected results, and there were several other interesting papers.

## T. Itoh and M. Sakano, Mitsubishi Heavy Industries

Research at Mitsubishi was presented by Takehiro Itoh and Mitsuru Sakano (JCF3-15, JCF3-16). Yasuhiro Iwamura, who has led the research program, is spending two years at another Mitsubishi research facility, devoting a few days a week to this project.

Last year at the JCF and ICCF conferences, Mitsubishi researchers described two sets of experiments, one with electrolysis, the other with gas loading.[2,3] This year the research team concentrated on the gas loading, which has less contamination and *in situ* XPS spectroscopy.

The metal target is a multilayer membrane, with bulk palladium on the bottom, a calcium or titanium alloy in the middle, and thin film palladium on top. The membrane is placed between a chamber holding deuterium or hydrogen gas and a vacuum chamber. The gas is pulled through the membrane into the vacuum. Samples exposed to deuterium show evidence of transmutations. Several researchers have reported that minute areas in palladium and gold cathodes have apparently transmuted into other elements. What sets the Mitsubishi result apart is that the material which is transmuted may not be part of the metal lattice where a nuclear reaction takes place. Thin layers of carbon, cesium, or strontium are deposited on the very top, above the second palladium layer, where it can be observed with the built-in XPS spectroscope. This layer of carbon or cesium is presumably not part of the nuclear-active material, yet it is transmuted. Perhaps a thin layer of strontium might generate its own cold fusion reaction in addition to the reactions in the palladium below it, but it seems unlikely that carbon can do this. Apparently, any atom in the vicinity of the reaction may be transmuted into some other atom. These transmutations bolster the hypothesis that the reaction occurs on the surface, very close to the surface, or at the interface where different materials come together. The Mitsubishi multilayer membrane structure itself suggests this, since it works much more reliably than the bulk palladium samples Mitsubishi started out with in the early 1990s. It seems to be general rule that multilayer cathodes and alloy cathodes, such as the palladium boron ones developed at the Naval Research Laboratory, work better than pure metal.[4]

Edmund Storms thinks the cesium and strontium must be alloyed with the palladium. They are deposited electrolytically. When electrolysis stops, the portion not alloyed will react with the water and dissolve away, leaving only a thin alloyed region within the palladium lattice. "In this alloy, they might well find themselves part of a nuclear-active environment." He points out that he saw excess power from divided carbon on platinum in electrolysis. "Carbon also might form a thin alloy region with Pd that is nuclear-active. We must not forget that these surface layers are small from our view point, but huge from the view point of an atom."

In the first set of Mitsubishi experiments, small amounts of carbon on the surface of the cathode apparently transmuted into magnesium, which in turn transmuted into silicon. They also found elements that convert into aluminum. These results might be called into question because carbon, magnesium, silicon, and aluminum are common elements, often found in contamination. Significant contamination is unlikely, however, because the entire apparatus is installed in a clean room, and every component in the deuterium chamber is carefully tested with different methods of spectroscopy to inventory the silicon and other contamination. Total silicon contamination was 10 to 100 times smaller than the transmuted silicon. The isotopic abundance of the silicon was very different from natural silicon, by one order of magnitude.

Despite these assurances, the researchers sought even more convincing evidence that the material they found came from transmutation and not contamination. They decided to test cesium and strontium, which are less likely, to be found as contamination than carbon. In one set of tests, they added a thin layer of cesium to the surface of the palladium membrane, using electrolytic deposition. They passed deuterium through the sample, stopping to evacuate the chamber and assay the surface twice, at 40 and 120 hours. They observed the cesium decline while roughly the same number ($10^{14}$) atoms of praseodymium gradually appeared. The XPS spectroscopy sees the surface layers of the sample, 3 angstroms deep, and Celani wondered whether the praseodymium might have been contamination from the electrolytic deposition, hidden at levels below the cesium. Itoh and Sakano explained that before installing the membrane in the chamber, they inventoried contamination in the membrane with different methods of spectroscopy and found no measurable level of praseodymium.

In the second set of tests, a thin film layer of strontium was electrolytically deposited. It apparently transmuted into molybdenum. As shown in Figure 1, the isotopic abundance ratio of the resulting molybdenum was particularly striking. This figure shows three ratios:

1. The isotope ratio of the molybdenum that gradually appeared on the surface during the 400-hour experiment. Roughly 70% is Mo-96. There is very little Mo-97 or Mo-100.

2. The ratio for naturally occurring molybdenum. Mo-96 is 17% of the total. The seven isotopes are about equally distributed, ranging from 10 to 20%.

3. The ratio for the naturally occurring strontium that was deposited on the surface before the experiment, most of



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which gradually disappeared over the 400 hours. Sr-88 is 83% of the total.

The huge fraction of Mo-96 in Graph 1 of Figure 1 appears to correspond to the Sr-88 in graph 3. Somehow four protons were added to each atom of strontium, converting it to molybdenum while preserving the isotope ratio of the original strontium.

The used membranes were sent to other laboratories in Japan and Europe to confirm the isotope ratios. As in all previous work, blank experiments were performed with hydrogen instead of deuterium. No apparent transmutations were observed.

The audience was impressed by the two Mitsubishi presentations, and offered enthusiastic suggestions. Many people want to see a radioactive species deposited on the surface, such as uranium or strontium-90. Sr-90 might gradually convert to Mo-98. This would be easy to detect, as the radioactivity falls. Sakano said they are thinking of testing radioactive species, but management hesitates to approve this work because of safety concerns.

The only drawback to this research program is that it is too good! It is done with superb control, accuracy, and skill and it produces the same qualitative results each time, although quantitatively there is significant variation between runs. The project employs the most advanced instruments that can be devised. It could only be reproduced by another gigantic corporation that devotes a clean room and millions of dollars in custom-made equipment to the task. Anything less will produce a less convincing result, if it works at all. The evidence for cold fusion includes excess heat and nuclear effects such as tritium, helium, neutrons, X-rays, and transmutation. Transmutation into stable, non-radioactive species is the most challenging form of evidence, and the most likely to be corrupted by contamination or at least be questionable because of contamination. Heavy element fission and transmutation may be the theoretical key to the process. A. Takahashi thinks fission might even be tuned to produce more energy than the fusion reaction which triggers it. So this project is of vital importance, but today only Mitsubishi has the money, the skill, and the will to undertake it.

Corporate policy at Mitsubishi discourages publication of graphs and data in informal conference proceedings or in the on-line JCF collection of viewgraphs. Management wants this data to appear in a peer-reviewed, high status journal. Last year they submitted a paper to *Nature,* which was rejected, to no one's surprise. This year they submitted a comprehensive twelve-page paper to the English edition of the *Japanese Journal of Applied Physics* (*JJAP*). It includes the latest versions of most graphs and tables they show during their presentations. They expect it will be accepted. The *JJAP* has published several cold fusion papers, including two in the last six months, so it is likely to accept this one and publish it sometime in the next three months. I rank this as one of the most important cold fusion papers ever written. The *JJAP* is Japan's leading journal of physics. This paper will probably not have much impact on public opinion. Unfortunately, opponents will probably continue to ignore these results. In a more sane world, this paper would be hailed in every science magazine. Still, people who are curious about the Mitsubishi research will finally be able to read the details in an authoritative journal.

## F. Celani, Italian National Physics Laboratory (INFN-LNF)

Francesco Celani reported some fascinating and excellent results from both the cold fusion research and a bioremediation project being formed around the *Ralstonia detusculanense* bacteria that he discovered has invaded most of the world's heavy water supplies (JCF3-5).

Celani's group at the INFN has concentrated on techniques to load a thin wire rapidly and to very high loading levels, above one atom of hydrogen or deuterium for each atom of metal. They use purified water or heavy water with a slightly acidic electrolyte, with a little strontium added. After the cathode achieves high loading, they add mercury, which forms an alloy with the palladium, sealing the surface to prevent rapid deloading. The technique has been independently replicated at the Pirelli Corporation research laboratory, and at SRI, which published a paper in *Physics Letters A* last year.[5]

Celani reported that compared to last year, the loading now occurs more quickly and reliably, achieving loading as high as 1.3 after a few hours, a process that took days last year. Fleischmann has visited the INFN laboratory frequently, and Celani says he was amazed to hear this. Fleischmann thought such high loading in such a short time was "impossible, or at least, it would take three months."

This high loading is determined by measuring the resistance of a segment of the palladium wire. In the past, some electrochemists have held that the loading ratio cannot exceed one. I asked several experts whether they think it can, or whether they suspect that Celani might be misinterpreting the resistance data. Some expressed doubts, but Storms says he thinks the results are real and Celani's work is "great." He has also measured compositions as high as 1.5 in 2-micron layers of palladium on platinum, using a different technique, gas displacement, to measure the composition.[6]

McKubre believes that both Celani and his own group did successfully reach loadings above 1.0 with this technique, but he cautions that measuring loading by resistance is tricky. Resistance rises with loading, but then falls off at very high loading. Because extreme loading is difficult to achieve and main-

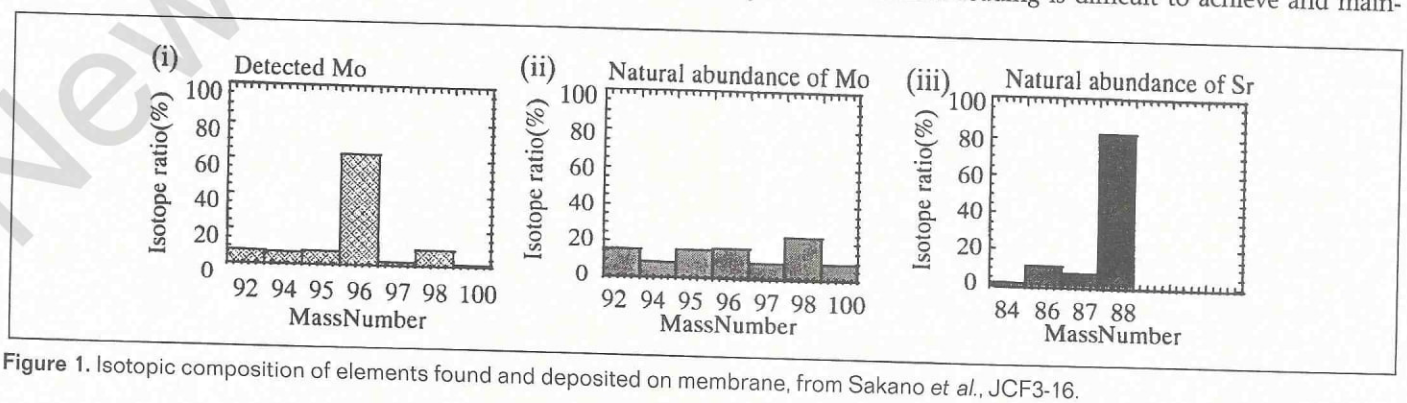


**Figure 1.** Isotopic composition of elements found and deposited on membrane, from Sakano *et al.*, JCF3-16.

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tain, it has seldom been studied and little is known about it. The standard equations to convert resistance to loading may not apply to this extreme condition. McKubre agrees that loading is above 1.0, it appears to have reached 1.05 in his tests, and it may be as high 1.5 in Celani's recent work, but exactly how high is not clear. He added:

> There is no fundamental reason why you cannot load Pd to 2 (or even 3). It either requires double occupancy of the Octahedral sites (as conjectured by no less than Linus Pauling and Julian Schwinger), or occupation of the Tetrahedral sites, as was much conjectured by the late Giuliano Preparata (being followed up now by Vittorio Violante), and others. There are published papers in the Russian literature at D/Pd = 1.33 from ion implantation.

McKubre explained, "Resistance ratios that look like loadings of 1.1 (or more) can easily be obtained in very thin wires (less than 125-microns) in periods of only a few hours. The problem is a thermodynamic one, *not* diffusion times (which are only seconds or minutes in these structures)." He says these ratios "look like" high loadings because of the uncertainty of the measuring techniques.

In their *Physics Letter A* paper, Tripodi, McKubre *et al.* suggest they may have observed a new loading phase. That is to say, hydrogen or deuterium atoms may be occupying the lattice in a novel arrangement. At room temperature the atoms occupy the first set of octahedral lattice sites in the alpha phase until loading reaches 5%. Mixed alpha and beta phase loading continues until the lattice is 70% loaded. Above 70%, all loading is in the beta phase, and according to conventional theory no other configuration exists. In 1992 Takahashi proposed that above 85% loading, deuterium begins to fill the tetrahedral sites. In 1995 Preparata made a similar proposal, calling this the third, or gamma phase, which starts at levels above 90%. Takahashi and Preparata both pointed to McKubre's data showing that excess heat in palladium does not begin until 80 or 90% loading is achieved, and they say this is evidence that fusion begins when tetrahedral sites begin to fill. (Loading is never uniform, and a sample that is 80% loaded on average will have areas with higher loading.)[7,8] Storms and others have proposed more conventional gamma phase structures, in which two deuterons occupy the same octahedral lattice site which holds only one deuteron at lower loading levels. Storms says this structure is similar to other hydrides and some carbides.

Tripodi *et al.* can only partly resolve this debate when they measure changes in the resistance of the palladium wire cathode. Based on electrochemical theory (Barton's method) they conclude these changes indicate gamma phase loading. This indirect method does not tell where, in the lattice, the extra deuterons fit in. The arrangement of deuterium atoms in the lattice can be observed more directly with neutron diffraction. That technique is expensive. Storms says it was used at Los Alamos to examine cathodes during electrolysis *in situ*. It had to be performed for long periods to capture a highly loaded spot, because highly loaded electrodes quickly decompose back to lower loading levels. The mercury "coating" preserves high loading for a remarkably long time compared to other methods, so perhaps it would be a good candidate for neutron diffraction.

Much attention has been paid to high loading, especially after McKubre showed convincingly that high loading corresponds to excess heat with palladium. Other researchers feel this emphasis is misplaced. They agree that high loading is necessary with palladium, but other metals seem to produce a cold fusion reaction without it.

Most tests for high loading have been performed with hydrogen. However, during a recent test with deuterium, Celani observed a spectacular heat burst. The cathode "glowed white hot" with very little input power. He feared the cell might explode from boiling electrolyte, or possibly produce a burst of ionizing radiation from the fusion reaction. He left the room in a hurry "because I have a family," and locked the door to keep everyone out. The cell is not equipped for calorimetry, so he does not know how much energy it produced, but the instruments did indicate that the intense heat continued for about 30 minutes, with peak output for perhaps five minutes. Input power is so low that normally the cathode does not become measurably warm at all, certainly not incandescent. Microphotographs of the cathode surface taken later showed some areas of local melting, which occurs at 1500°C with palladium. There were also many small holes eaten into the surface of the metal. Part of this metal wire protruded above the water line, and microphotographs of this portion showed no damage or melting.

Celani wisely decided to vacate the room and lock the door in the face of this violent and unexpected reaction. Mizuno also felt alarmed, and took similar precautions in April 1991 when his 100 gram cathode began to produce intense heat-after-death the day after electrolysis ended.[9] Until cold fusion is well understood and can be controlled, no one will know whether such reactions might lead to a harmful radiation. A reactor that suddenly and uncontrollably increases output by a huge factor would explode. The reaction might eventually be controlled by rule of thumb, learned by experience, but it seems more likely that a comprehensive theory will be needed. Without pinpoint control, cold fusion will probably never be developed into a practical source of energy. Perhaps it can be used in large-scale plants, in shielded reactors. Conventional energy sources such as a burning pile of coal, fissioning uranium, or large wind turbines cannot be quenched quickly, or regulated with instantaneous pinpoint control, so they are only suitable for large scale generation, not for individual houses or cars.

The *Ralstonia* bacteria can disrupt cold fusion electrochemistry. It may have caused undetected contamination in many failed experiments. People do not expect to find bacteria infesting nominally 99.9% pure heavy water, especially bacteria that eats mercury, lead, cadmium, and radioactive species including uranium. You might kill all but one bacterium, and a few days later the surface of a cathode is again thickly covered with bacteria munching away at the metal and preventing loading. It seems to thrive on the mercury-palladium alloy Celani employs. The lithium electrolyte used in most experiments is toxic to the bacteria, but the bacteria will still be a serious source of contamination, since killing them releases carbon and the heavy metals they have ingested. Celani recommends cleaning heavy water with triple distillation.

Last year, Celani reported that *Ralstonia* has stirred up interest for two reasons unrelated to cold fusion. First, under the right conditions, one strain of it placed in bright sunlight produces free hydrogen from water. This might be a source of hydrogen fuel from solar energy in desert areas. Second, *Ralstonia* is being investigated for its ability to metabolize heavy metals, and to survive intense radiation, as high as 30 mega-rems. (Five hundred rems will kill a person.) It might be

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useful for bioremediation: cleaning up water or dirt contaminated with soluble heavy metals, such as mercury, lead, cadmium, and uranium, including radioactive isotopes, which contaminate nuclear waste dumps and decommissioned reactors. Heavy water is a hostile environment for living things. In large amounts it poisons animals. It often contains tritium and other radioactive elements. Purified heavy water did not exist on Earth until the 1940s. Sometime after that, the first *Ralstonia* may have entered a vat of heavy water, survived, and rapidly evolved to thrive in it.

A nascent bioremediation project is underway, staffed by an eclectic, interdisciplinary team including physicists, three biologists, and three medical doctors. Recently this research made the front pages of the national economic newspaper and the Italian version of *Scientific American*. Both published glowing praise of "cold fusion researchers" for this conventional breakthrough. A high government official authorized an immediate infusion of funds, to be followed by a large project with a budget in the hundreds of millions of dollars. Some of this funding will go to cold fusion. I fear Celani may be distracted from cold fusion research, but he says he will not be, and after all he is a physicist, not a biologist.

Presumably, bioremediation would be done by growing the bacteria in water solutions of heavy metal, or a slurry of contaminated mud and water, or ground-up low-level rad-waste. The bacteria would then be filtered out of the water. The bacteria concentrate the metals in one place. Bacteria are much larger than individual heavy metal atoms, and easier to separate out. The techniques being tested now are much more expensive than simple filtering. They are designed to find out precisely how much heavy metal the bacteria are capable of removing from the solution. Celani explained, " . . . to validate our experiments we used the standard ISO 2002 ultra-centrifugation methods (which are very, very expensive!!!)." They used $HNO_3$ at 80°C to chemically attack the bacteria for two hours. After dissolution, ICP-MS analysis is performed to find out exactly what the bacteria ingested. This part of the research is being performed in a third-party, ISO 9002 certified laboratory, the Centro Sviluppo Materiali. Results indicate that the water treated by *Ralstonia* is "clean enough to drink."

Fortunately, this hardy bacteria cannot infect humans or other animals.

## Projects at Yokohama National University

The morning before the conference I visited Prof. Ken'ichiro Ota and his students, who hosted the conference. Ota is a charming and dedicated scientist, who inspires young people. He has led students working on cold fusion since 1989. Unfortunately, he and his teams have seldom measured excess heat or other cold fusion effects. Adversity and personal misfortune have interrupted some fine projects before they reached fruition. Last year at JCF-2 they described a superb new flow calorimeter they built from parts inherited from the NHE program. They intended to use this in a new set of studies of nickel cold fusion. Just as they began, the graduate student in charge became seriously ill, and was forced to withdraw from the university. He has not returned, and the equipment is beginning to look dusty and abandoned. After a while, seals will decay, pumps and other precision instruments will degrade.

Last year Ota and his students reported on a rather crude attempt to replicate the Patterson light water nickel and nickel-palladium bead cathodes. They had superb calorimeters, but they were using nickel rods, which had been chopped into 1-mm segments, shaped like tiny marshmallows. This seemed so different from Patterson that it could no longer be called a replication. Ota explained that earlier, they tried a much closer replication, using plastic beads coated with copper and thin film nickel and palladium, according to patent. They realized they did not have the expertise to produce the beads on their own, so they went to "a leading Japanese company that specializes in such things—probably the best around." Those beads produced no heat, so they tried a variety of other methods, gradually deviating from the original technique. They asked Patterson for assistance and he referred them to his U.S. patents, telling them that that was all they needed to do a replication. Recently they have acquired a high quality UVLAC sputtering machine, which will produce a clean, even, thin layer, better than the layers they make with electrolytic deposition. George Miley recommended this approach.

This year's experiment is being performed by M. Fujii (JCF3-2). He built two more flow calorimeters, again using high quality pumps, flowmeters, and other equipment inherited from the NHE. They can be run in parallel, with one for a blank sample. (It may be difficult to find a blank with nickel, which some people say produces excess heat from ordinary water.) This instrument is not as accurate or precise as last year's calorimeter, but it is better suited to this experiment, and tests show that the heat recovery rate and accuracy are satisfactory.

The cell geometry is the opposite of Patterson's. It is a broad cylinder with a few layers of beads; Patterson used a thin cylinder with ten or more layers. Storms thinks that the former will be more effective, and more beads will be loaded. With a tall, thin cell with ten layers, he thinks that only the first or second layer will absorb hydrogen, and layers above that play no role.

In a total of nineteen runs, Fujii observed no excess heat in one case, and less than 10% excess fourteen times. This low level heat may not be significant. They saw significant excess heat 4 times, which peaked at about 10 watts input, 16 watts output, 6 watts excess. I have some concerns about the experiment, and Ota is also cautious. He wrote, "We observed clear excess heat four times out of many trials this spring. However, we cannot reproduce right now. So, it will take more time to reach a final conclusion." What bothers me is that the peak output usually occurred very soon after electrolysis commenced. Data is collected every three minutes, and the first three-minute point is already well above the zero line. In one example, the heat peaks ten minutes after electrolysis begins. It fluctuates, but the trend is downward. Fujii said he turned on the data recording at the same time he started electrolysis for the first time. In the Patterson data, and other cold fusion data sets I have seen, there is a delay after electrolysis begins, before the onset of excess heat. With Patterson, the delay is at least 20 minutes the first time they run a set of beads. It is 5 or 10 minutes when the beads have been loaded previously and are still saturated.

The four samples that produced excess heat had layers of thin film palladium and nickel deposited on solid nickel beads. Perhaps these beads loaded very quickly, and began producing heat nearly instantaneously, but I fear the results may be an instrument artifact of some sort, although I cannot imagine what it might be. The equipment and techniques seem well designed. The inlet and outlet tubes are a quarter inch diameter which is a good size, and the flow rate is a vigorous 40 ml per minute. Very narrow or exceedingly fat tubes and a sluggish flow of water can cause mixing problems, streamlines, or stagnant cooling fluid. Six watts of apparent excess heat causes a

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two-degree difference between the outlet and the inlet, which is a large temperature difference, easily measured.

Fujii and Ota express confidence in the instruments and calorimetry. I made some minor suggestions: They might try a joule heater calibration during electrolysis, adding a pulse of electric heating to the electrolysis. They might try switching off electrolysis during high excess heat output to look for heat-after-death.

As Ota said, if they can replicate, it will enhance everyone's confidence. This would be a valuable contribution to the field, because there have been few quality replications of excess heat from nickel. To track down the difference between the cathodes that produced heat and those that did not, they are performing various analyses and examinations of the used beads. There are no obvious differences between good and bad beads. Both come out fractured by the intense pressure of electrolysis and coated with contamination from the circulating electrolyte. This technique invites contamination, from the pumps and holding tank. Although Fujii has worked hard to reduce this contamination, the beads stop producing heat after several days. By the time Fujii stops the experiment to analyze the beads, the beads are ruined and indistinguishable from the beads that never worked in the first place. It might be a good idea to stop the process when the beads are still producing heat at peak levels the first day.

## Takahashi Group Continues Particle Beam Loading

Many of the JCF presentations are devoted to particle beam cold fusion (as is much of the research in Japan). Akito Takahashi, of Osaka National University, has been the main proponent of this approach, and most of the papers are by his graduate students (JCF3-22 - JCF3-25). He is one of the senior scientists at the 30-meter accelerator at the Department of Nuclear Engineering, so he is entitled to use the beam for several hours a month. They have also constructed smaller accelerator beams for cold fusion studies. He published a paper about his fusion theory a few years ago.[10] A deuteron beam is used to load samples of Ti or Pd. This causes conventional fusion, as deuterons impact on ones that are already implanted in the metal, in "pile up" and "double pile up" reactions. Takahashi believes that in addition to these conventional reactions, another set of anomalous nuclear reactions are taking place, in which three deuteron fuse together, which he predicts should be largely aneutronic. He finds evidence that this three-body reaction occurs $10^{26}$ higher than predicted by conventional theory. He thinks similar reactions occur in cold fusion cathodes and gas-loaded finely divided particles.

The difficult part of these experiments is to distinguish between the particles produced by conventional nuclear reactions and cold fusion reactions. Conventional fusion reactions must be identified and subtracted out from the data, leaving evidence that Takahashi and his coworkers think points to the 3-body reaction. It takes an expert in high energy particle physics to fully appreciate and evaluate this research. Charged particle Ek-detectors (silicon signal detectors - Si-SSD) are set at different angles around the sample, typically 90 and 120 degrees from the deuteron beam path. Thin foil is often placed in front of the detectors to filter out some of the particles. Particles are identified by their energy level and also by the shape of the peaks that identify them. Tritons from D-D collisions (on the low end at around 0.5 MeV) are conventional, expected fusion products. Unexpected peaks include helium-3 from 3D collisions, and tritium. The helium-3 signal is very close to the signal of protons from D-D pileup reactions, and thus, difficult to distinguish from it. (In particle physics jargon, it is "on the shoulder of" the D-D proton 2.5 MeV reaction.) Various other clever techniques are used to distinguish between particles. For example, a thin detector may be placed in front of a thicker one, to act as a filter. A 26 micron slice of silicon intercepts 4.75 MeV helium-3, but 4.75 MeV tritons pass through it. They are captured by a thick, 200-micron slice of silicon.

Takahashi believes that these fusion reactions give rise to heavy element fission, of a type he calls "multi-photon induced fission (MPIF)" according to his "selective channel scission (SCS)" model. This fission produces mainly stable, Beta decay products. This induced fission explains the transmuted elements found in used cathodes. He thinks it may be possible to "fine tune" the fission by lowering the energy from fusion, to prevent the formation of unstable (radioactive) species, although he says this is only speculation at this stage. Thus, it might be possible to reduce transmutation with a palladium cathode, which would save money because palladium is expensive and produces very little energy from fission compared to 3-body fusion. On the other hand, it might be possible to increase fission with a uranium target. This would be depleted uranium, which is safer than the enriched form used in fission reactors or bombs. The uranium fission would produce roughly ten times more energy than the cold fusion reaction which triggers it. None of the products from the palladium or uranium would be radioactive.

It is dangerous to try to draw conclusions from the entire body of evidence from all cold fusion research, because the experiments are such a heterogeneous mixture of good and bad research. However, overall results do support Takahashi's conclusion. Only a few experiments have produced radioactive, short-lived heavy metal transmutations. The best known, most carefully verified one was performed by the late Kevin Wolf at Texas A&M.[11] Others were reported by Robert Bush[12] and Y. Kucherov *et al.*[13] Many studies have produced stable isotopes. Because it is difficult to distinguish between minute amounts of stable transmuted elements and contamination, some of these findings are probably mistakes, but there are enough solid, rigorous results, especially from Mitsubishi, that I am now convinced transmutation does occur. Evidently, in nearly every case, it results in stable elements. That is good news for the prospect of making practical energy generating systems, but it is awkward for our present purposes. Radioactive species can be detected in tiny amounts, much smaller than spectroscopy can measure, and they are instantly and unambiguously distinguished from contamination. If Takahashi can put his theory into practice, fine-tune the reaction, and force it to produce radioactive isotopes, he will do a great service to the field for two reasons:

1. The result would be very convincing, as Wolf's result was.
2. It would show what we must avoid doing in a practical energy generating system.

A particle beam loading experiment is not intended to be a practical form of cold fusion, but rather a research tool to reveal the mechanism of the reaction by loading metal samples with deuterons rapidly and uniformly.

*Newsweek* (its website) recently wrote: "Takahashi says if he doesn't get good results in two years, he'll retire."[14] This is *not* what Takahashi told the reporter. He said he will reach



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mandatory retirement in two years, when he must leave regardless of the state of his experiments. Takahashi already thinks he has "good results." Unfortunately other researchers, especially those who have access to large particle beams, have largely ignored his work. Unless it is replicated, and others agree the results are real and do indicate a huge increase in three-body reactions, I fear this line of research may die out after Takahashi retires.

## Some Other Papers

Tadahiko Mizuno reported on results published in the last issue of this magazine (JCF3-4).[15] When palladium saturated with deuterium was electrolyzed in ordinary water, and voltage was increased, a burst of neutrons is detected in about half the tests. Mizuno emphasized that his neutron detector, provided by NTT, is insensitive but highly reliable. That is to say, it fails to detect most neutrons, but when it does report a neutron, there is little chance it is actually seeing some other particle or electrical noise. Thus, a 10 second burst peaked at 7.7 measured neutrons per second, but this is extrapolated to be a $4.4 \times 10^5$ neutron burst when you take into account the insensitivity and the small surface area of the detectors.

Some people have wondered whether the neutrons Mizuno observed might be caused by fractofusion, that is, crack formation causing a difference of potential that accelerates deuterons to cause minute levels of D-D fusion. This is a conventional phenomenon. Mizuno and Takahashi think this is very unlikely. The energy level of the neutrons Mizuno observes is much lower than the D-D 2.5 MeV neutrons, the energy waveform looks quite different, and many samples loaded with deuterium developed cracks but did not produce neutrons. Takahashi adds that electrochemical conditions make it unlikely that deuterons will be accelerated. The potential difference created when a crack forms will quickly be weakened by field electrons migrating from one side of the crack to the other.

Takahashi's students have recently attempted to replicate this experiment. They made ten runs and saw a short but significant neutron burst of 7 counts per second in one run, using a helium-3 detector, where the background is one count every two minutes. Unfortunately, they did not detect anything on the NE213 detector used in parallel.

Tadayoshi Ohmori discussed the glow discharge effect with rhenium cathodes (JCF3-6). He believes he has found evidence that it converted K-39 into K-40. He recently published an impressive eighteen-page paper with photos and SEM images.[16]

Some of the people who show up at these conferences work on anomalous or "over-unity" energy claims loosely associated with cold fusion. In my opinion, many of these claims are not worth the effort it takes to investigate them. A retired professor, Teruo Hanawa, is doing a brave job trying to sort out claims about excess heat produced when an underwater carbon arc fractures water into free hydrogen and oxygen gas (JCF3-8). He is trying to measure the energy balance during the production of the gas, which as far as I know is not supposed to be over-unity. When the gas is burned, the heat generated by it is reportedly greater than the energy required to fracture the molecules and produce the gas. It is very difficult to measure the input power and heat from this violent reaction. Hanawa is working on a shoestring with obsolete instruments. He is ingenious and experienced. He has overcome many problems, but so far he has only been able to make a crude estimate that about half the input energy is recovered as heat. The other energy is presumably carried off with the gas. He has not yet been able to ignite the effluent gas, which will make the experiment even more difficult. I predict the claims are wrong, and he will see no excess heat.

## Some Poor Replications

A few of the experiments presented seemed rather sloppy, with problems in material purity. Some replications were quite different from the original experiments they targeted. Takahashi should have supervised his undergraduate Masayuki Matsunaka more closely (JCF3-7). During Matsunaka's presentation, Mizuno and I tallied a half dozen serious errors, such voltage set far below the levels Ohmori and Mizuno recommended, and bad geometry. The anode was the same size as the cathode, so it grew equally hot, and both were not attached firmly to the lead wires, so they repeatedly heated up and fell off. It is a shame to see so much hard work wasted by mistakes that could be avoided by conferring with the researcher who did the experiment first. During one of the conference breaks, Mizuno took Matsunaka aside and reviewed and contrasted his own work, Ohmori's, and Matsunaka's replication.

As explained above, Fujii and Ota knowingly deviated from Patterson's original experiment, for good reason, but others seem to be careless, inattentive, or they simply do not see much value in paying strict attention to the original experiment they attempt to replicate. This problem has plagued the field from the start. Cold fusion attracts strong-minded individualists who forge ahead despite harsh public opinion and countless setbacks. This is both a strength and a weakness. Such people are often impervious to advice. They may not be willing to spend enough time learning from others, or imitating others. They do not pay enough attention to other people's rules, procedures, recipes, and hypotheses. As Mizuno said, "If we were not such stubborn stick-in-the-muds, we would have quit this business long ago."

## Overall Trends

Two trends emerged from the conference discussions and questions. One is that more attention should be paid to the purity and cleanliness of the heavy water, the anode, the reagents, the cell vessel, and other components. Researchers have always known that cathode cleanliness and pretreatment methods are important, but not enough attention has been paid to system impurities from all cell components. Celani, in his wire-loading protocol, recommends adding 20 mg of strontium to the electrolyte, but he points out that system impurities in some cells are 200 mg or more, which may swamp the effect of the strontium, and make the results uncontrolled and unpredictable.

The second trend is increased attention to heavy element transmutations. Years ago, practically no one believed that cold fusion can produce fission-like transmutations. The first evidence for cathode metal transmutations was reported by J. Bockris, T. Mizuno, and G. Miley. It was generally ignored, although the people at Mitsubishi have been quietly and diligently working on the subject since the early 1990s. Now the phenomenon has become the focus of most remaining research in Japan. In a sense this may be a dangerous distraction. The public will only be enticed by energy and, without public support, the field will remain in grave trouble. A few researchers still concentrate on high heat and energy generation, including Ohmori and Celani. Other groups in Italy are still thinking about how to ramp up energy output. The study

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of transmutations might lead to a theoretical breakthrough, which in turn would lead to better understanding and control of energy. Some researchers feel that the transmutation data might lead to wider acceptance of the field, since the transmuted elements are not transient, like heat or neutron emissions. The isotope ratios of a sample can be measured repeatedly, years after the experiment ends, and in some cases these ratios prove that a nuclear reaction occurred. Ideally, a researcher might give a sample of transmuted material to a skeptical critic, who would use his own instruments to verify the transmutation. In practice, no important skeptical expert would look at a sample. Even if one did, and he saw element isotope ratios that do not exist in nature, he would claim that this is an instrument error, or he might come up with some outlandish explanation, like the skeptic who told me he thinks cold fusion scientists secretly purchase pure mono-isotopic material from Los Alamos and implant it in the metal.[17]

One of the conference participants worried about the focus on transmutations. He told me, "These are such minute quantities of material, and it is so difficult to ensure they are not contamination, I fear we can never establish these results well enough to satisfy the critics." With such limited funding, and with many professors like Takahashi facing mandatory retirement soon, it may be a mistake to focus on such difficult, time-consuming experiments.

## General Information About the Conference and the JCF

Most presentations at the JCF conferences are in Japanese. The abstracts and many of the viewgraphs are in English, which makes it easier for me to understand. It is a little like watching a movie with English dubbing.

Abstracts from the conference were posted on the JCF website in September.[18] Although the abstracts contain a few Japanese characters, most people say they display correctly on a U.S. computer with the latest version of Acrobat Reader. Takahashi and I have some extra copies of the printed book of abstracts distributed during the conference. Readers who cannot view the website may contact me for a copy.

Some of the viewgraphs from JCF2 lectures were posted on this website last year, and the organizers hope the scientists will again post viewgraphs on the web in lieu of a formal Proceedings. (Viewgraphs or slides are listed under "JCF2 OHP," which stands for "Overhead Projector.")

The next JCF conference will be held at Iwate National University.

## Presentation Titles

Here is a list of JCF-3 presentations. The "JCF3" prefix indicates the order in which papers were presented, and listed in the book and the on-line Acrobat file.

Opening Address (K. Ota, Yokohama N.U. [National University])

*Electrolysis Light and Heavy Water session (Chairman A. Takahashi, Osaka U.)*

JCF3-1 H. Yamada *et al.* (Iwate U.) Nuclear Transmutation by Light Water Electrolysis with Palladium Cathode

JCF3-2 M. Fujii *et al.* (Yokohama N.U.) Heat Measurement During Light Water Electrolysis Using Pd Rods and Pd/Ni Rod Cathodes

JCF3-3 Y. Isobe *et al.* (Osaka U.) Study of Nuclear Reactions in Metal-Deuteride by Closed-Type $D_2O$ Electrolysis

JCF3-4 T. Mizuno *et al.* (Hokkaido U.) Neutron and Heat Generation from a Palladium Electrode by Alternate Absorption Treatment of Deuterium and Hydrogen

*Special Talk (Chairman A. Takahashi, Osaka U.)*

JCF3-5 F. Celani *et al.* (INFN-LNF) Electrochemical H-D loading of Palladium Wires by Hydro-Alcoholic Electrolytes Related to the new Discovered Ralstonia Bacteria into Heavy Water.

*Electrolysis Plasma State Session (Chairman T. Itoh, Mitsubishi Heavy Industries)*

JCF3-6 T. Ohmori *et al.* (Hokkaido U.) Nuclear Transmutation from $^{39}K$ to $^{41}K$ in the Plasma Electrolysis on Re in $K_2CO_3/H_2O$ and $D_2O$ Solutions

JCF3-7 M. Matsunaka *et al.* (Osaka U.) Studies of Photon Source for Multi Photon Induced Fission under Plasma Electrolysis

JCF3-8 T. Hanawa (Osaka U., Emeritus) Calorimetry of Submerged Carbon Arc

*Theory-1 Session (Chairman K. Ota, Yokohama N.U.)*

JCF3-9 T. Sawada (Nihon U.) Implications of $^4He$ Dominance in D+D Reactions

JCF3-10 T. Sawada (Nihon U.) Proposal to Identify the "Nuclear Active State"

JCF3-11 H. Yamamoto, A Study on Anomalous Characteristics of Gasses Generated by Under-Water Electric Arc Discharge with Carbon Electrodes

JCF3-12 N. Yabuuchi (High Scientific Research Laboratory) Possibility of Nuclear Fusion in Solid

**JCF Annual Meeting**

*Gas and Vacuum Phase Experiments Session (Chairman T. Mizuno, Hokkaido U.)*

JCF3-13 A. Arapi *et al.* (Iwate U.) Generation of the New Elements and Isotopic Changes on Deuterated Palladium Electrodes under DC Glow Discharge

JCF3-14 S. Narita *et al.* (Iwate U.) Anomalous Heat Effect for Palladium Hydride in Gas Out-diffusion Method

JCF3-15 T. Itoh *et al.* (Mitsubishi H.I.) Observation of Low Energy Nuclear Reaction Induced by $D_2$ Gas Permeation Through the Multilayer Pd film (1) - Transmutation of Cs into Pr

JCF3-16 M. Sakano *et al.* (Mitsubishi H.I.) Observation of Low Energy Nuclear Reaction Induced by $D_2$ Gas Permeation Through the Multilayer Pd film (2) - Transmutation of Sr to Mo

*Theory-2 Session (Chairman T. Ohmori, Hokkaido U.)*

JCF3-17 M. Fukuhara, Neutral Pion-Catalyzed Fusion in Palladium Lattice

JCF3-18 K. Tsuchiya (Tokyo N.C.T.) Effects of the Bose-Einstein Condensation to the Nuclear Reaction in Solids II

JCF3-19 A. Takahashi *et al.* (Osaka U.) Cold Fusion and Clean Fission

JCF3-20 M. Ohta *et al.* (Osaka U.) Analysis on Fission in U-235 by SCS Model

*Beam Solid Interaction Session (Chairman H. Yamada, Iwate U.)*

JCF3-21 K. Kamada (The Wakasa-wan Energy Research Center) Heating of Deuteron Implanted Al on Electron Bombardment and its Possible Relation to "Cold Fusion" Experiment

JCF3-22 T. Hayashi *et al.* (Osaka U.) Studies of Nuclear Reactions in Solids in Titanium Deuteride under Deuteron Beam Irradiation

JCF3-23 Y. Katayama *et al.* (Osaka U.) Studies of Nuclear-reactions-in-solid in Titanium-deuteride under Ion Implantation-III - Experiments with Proton and Si 3+Beam Implantation

JCF3-24 T. Dairaku *et al.* (Osaka U.) Analysis of Charged-Particle-Spectra Obtained under the Implantation of Ion Beam to TiD, TiDH, and TiH

JCF3-25 H. Mori *et al.* (Osaka U.) Studies of Nuclear Reactions in Solids under Electron Beam Irradiation to Metal Deuteride

JCF Conference Report continues on page 37

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# A Modified Orgone Accumulator (HYBORAC) as a Drive for a Low Delta-T Stirling Engine

## PART I

Paulo N. Correa and Alexandra N. Correa*

**Abstract**

In the present report, the first of a two-part series, the authors demonstrate a method to optimize the solar-sourced anomalous To-T difference registered in Orgone Accumulators (ORACs) invented by W. Reich in 1939-1940, and employ this optimized difference to drive low delta-T Stirling engines of the MM6 type, thereby putting into evidence how this thermal anomaly can be exploited to perform "free" work. For this purpose, we employed a novel ORAC design (which we termed the HYBORAC)—a specially-built hybrid arrangement designed to be directly exposed to solar radiation (as filtered by the terrestrial atmosphere) and composed partly of a black-painted ORAC and partly of a Faraday cage—and a few simple modifications of the Stirling motor, to achieve hour-long midday motor speeds on the order of 20 to 140 rpm, with ΔT's ranging from 5.7 to 21°C. Prospects of further approximating the engine ΔT to the full value of To-T and increasing the To-T difference to >30°C, are discussed and proposed in the present report. (Note: To = Temperature of HYBORAC top plate surface that Stirling bottom plate rests on; T = Temperature of ambient air.) Results from the continuation of this work are presented in the companion essay, which will be published in the next issue of *Infinite Energy*.

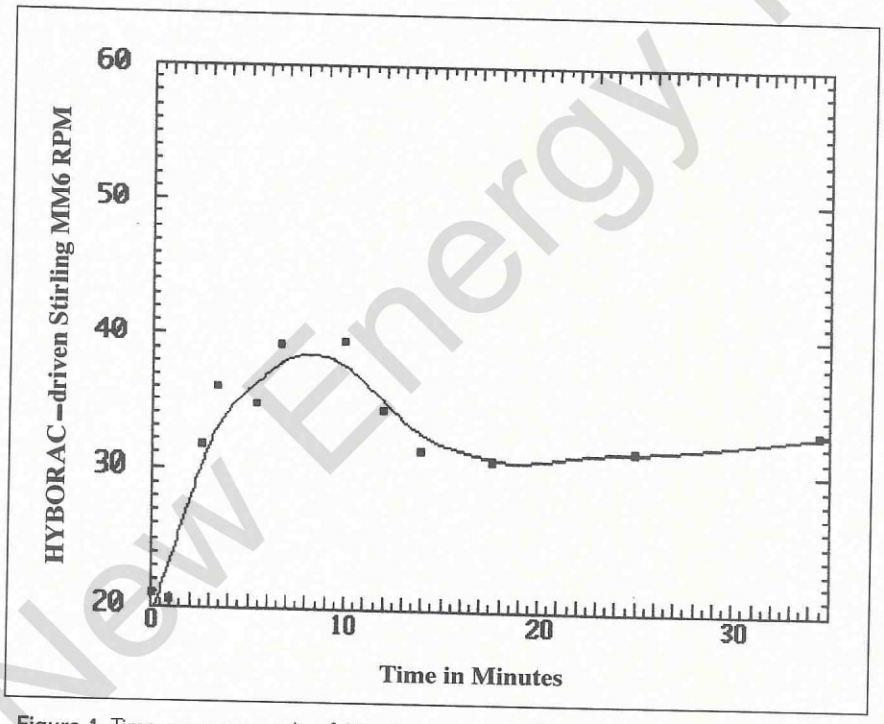


**Figure 1.** Time course sample of 35 minute duration for the October 1, test of a solar-exposed HYBORAC drive of a low delta-T Stirling motor. Observed deceleration from 10 minutes onward is caused by the appearance of altostratus haziness in the sky. Time zero was set at 13:58 EST.

### Introduction

Stirling motors have existed for nearly two centuries; they were originally referred to as hot-air engines. First invented and patented by Scotsman Robert Stirling in 1816, Stirling motors were widely used during the nineteenth century as water pumps for well applications. More recently, Stirling motors capable of moving with low ΔT values were designed by I. Kolin at Zagreb University,[1] and J. Senft at the University of Wisconsin River Falls.[2] D. Kamen and associates have also developed a Stirling engine driven by direct combustion.[3] For reference to the mechanism of action of the Stirling motor please consult reference four.

These authors were largely unaware of the Stirling technology until Dr. E. Mallove privately brought to their attention the possibility of employing low delta-T Stirling motors to exploit the thermal anomaly of ORACs. It was evident to us that one of the plates of the Stirling should be placed on the top plate of the ORAC or of a Faraday cage. Dr. Mallove obtained a Stirling motor (model MM6)[5] from the American Stirling Company, in July 2001, and mounted it on the top plate of a small, crude ORAC, but was unable to drive it from the low values of ΔT that he observed. We knew this would be the case, since neither the Reich-Einstein-type of experiments[6] nor ORACs placed indoors or in the shade outdoors[7] can produce values of To-T that would fit the minimum ΔT = 4°C of model MM6. But an ORAC directly exposed to solar radiation would have no trouble in sustaining To-T values in excess of the minimum ΔT purportedly required by the MM6.

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## Methods and Materials

On September 28, 2001, these authors received from Dr. Mallove this same motor as a gift. The first experiments carried out outdoors with a plain Faraday cage did not succeed. Control tests were immediately conducted at 16°C room temperature, by employing a blower heater. Heating of the top plate sustained CW motion, and heating of the bottom plate sustained CCW motion—from the perspective most distal to the rotor shaft. The motor, of course, had to be "kickstarted" with a gentle push. By placing two sensitive calibrated thermometers against the surface of both plates, in copper sockets designed to ensure all-around good contact with the mercury bulbs, we found that the minimum ΔT required to sustain motion was 13°C when the top plate was heated, and 11.6°C when the bottom plate was heated. Upon passive cooling of the heated warm plate, the motor ceased to work as the 12.6°C or 9°C thresholds were crossed.

These control findings immediately placed a much greater onus on driving this motor from a Faraday cage or an ORAC — they showed that the test could not be attempted with as small a delta-T value as 4°C, but required three times that value, 11-13°C. This lifted the bar substantially. Moreover, the placement of the motor plates also appeared to be counter-intuitive, with the top plate of the engine constrained by the arrangement to be the cold plate, and being placed ca 1 inch above the warm plate—thus making it difficult to avoid heating the top plate, both from above (by solar radiation) and from below, when the bottom plate of the engine is set as the top of a sun-exposed Faraday cage or ORAC.

How could the top plate be made to adopt the air temperature of control thermometers under these conditions? That was the second cause of our initial difficulties.

As soon as we next had time to dedicate to this problem—on October 1—we tackled these two issues. We had, years back in 1998, designed special "inverted layer" BORACs (unpublished data; the metal and dielectric layers of the inverted BORAC are ordered in the reverse order of a normal ORAC) that achieved outer temperatures of 70°C and inner temperatures greater than 50°C. A test with such an ORAC on October 1, shortly before we retested the Stirling coupling, had given inner temperatures of 51.5°C by 11:30 in the morning. So, our challenge was to learn from the previous lessons of this special, "inverted-layer" BORAC—and to determine how best to design an ORAC device that maximally trapped sensible heat. To begin with, we had to bring that top plate, despite its short distance from the ORAC top, to cool down to the control temperature range.

## Results

The solution was to halve a cube along a diagonal plane and transform three of its facets into a (normal) BORAC[7] whose length unit is 12 inches, and the other three facets into a Faraday cage (constructed of galvanized iron) whose length unit is 8 inches, centering a vertex of the latter against the central vertex of the former. The BORAC-half of the device was insulated with dark cork amalgamate, and one of its insulated facets was also employed as the stand for the entire device. The Faraday cage employed was effectively a six-facet box upon which the Stirling contraption (motor and mount) donated by Dr. Mallove could be mounted. As the box was centered along one of its vertical edges into the ORAC half-cube, the edge of their juxtaposition was employed as the center of the apparatus to be oriented towards the sun. Thermometers were assembled on both plates of the Stirling motor, by the procedure described in the Introduction.

We named the new BORAC device—which is a perfect hybrid between a single layer Black Orgone Accumulator and a smaller Faraday cage—HYBORAC, for Hybrid Black Orgone Accumulator/Faraday Cage. The HYBORAC aims at capturing a maximum of radiant energy—whether electromagnetic (*e.g.* optothermal photons), latently thermal[8] or ambipolar electric (specifically orgone energy)—and converting these incoming energies into a maximum output of sensible heat at the top plate of the device. It also ensures that maximum insulation and retaining action (including reflection) occurs on the sides of the device not exposed to solar radiation.

To address the problem of cooling the top plate of the MM6 down to the level of the control thermometer, we insulated it from the top with a layer of felt, and also devised a shadow stand that was moved periodically to adjust for solar movement. This did not completely achieve the intended objective, but was nevertheless a great improvement. Within the test day, the temperature of the top plate varied in the range of 28-32°C, while the air temperature thermometer varied between 16° and 24°C. This leaves obvious room for improvement, which we discuss below with respect to our final design, and discuss further in the companion report.

With these two modifications, we were able to drive the Stirling MM6 from the HYBORAC with a 10.6°C delta between the two plates.[9] We began the test at 13:58 on October 1, 2001.

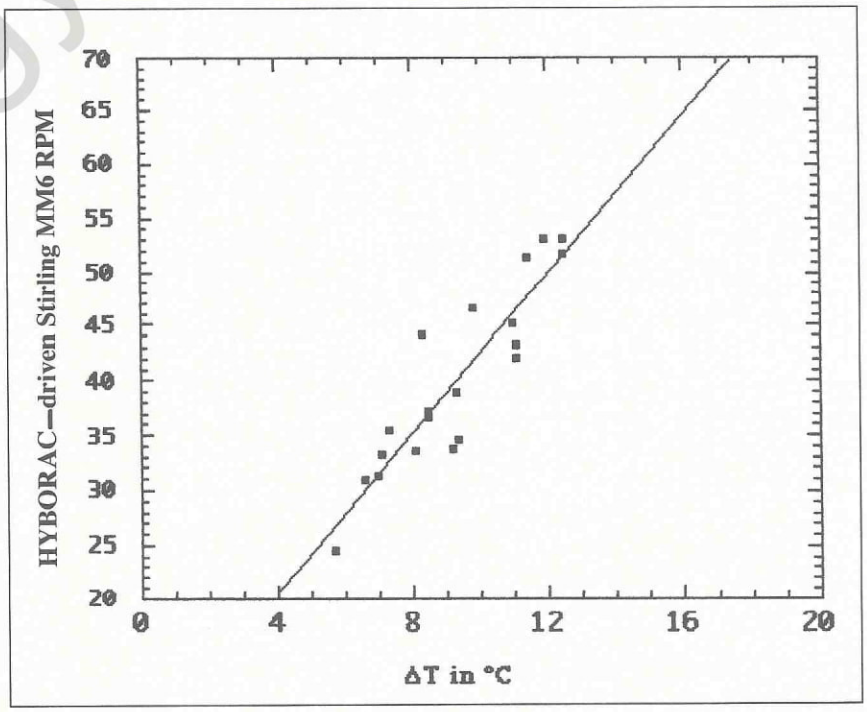


**Figure 2.** Linear regression relating the observed covariance of the Stirling motor speed and increasing delta-T fed from the To-T of the HYBORAC.

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It was a beautiful sunny day with some accumulation of humidity around midday, and some ice cloud formation that began by 12:00, when outdoor relative humidity was 55%. At that time, the outdoor electroscopic leakage rate was relatively fast, on the order of 8kV/hour. The CCW speed of the Stirling motor, sluggish in the first two to three minutes, is shown—for the first half-hour of the test—in Figure 1. Before the test, the motor had been running since 12:33 with speeds that reached 47 rpm and ΔT's of 7 to 11°C. A few cirrus clouds formed around 13:10, and by 13:30 grey altocumulus were visible and moving from the west in the direction of the sun, succeeding in obnubilating it by 13:44. The motor took about four minutes to come to a stop when the ΔT decreased to 5.7°C. At 13:51 the sun broke through the clouds and it took another seven minutes for the ΔT to reach the re-starting value of 10.3°C. The recovery curve is shown in Figure 1; it is well under way by the fourth minute (240 sec), and would likely have risen further to indicate greater motor speeds after 10 minutes, were it not that altostratus haziness became accentuated from 13:55 onwards. But this was not enough to bring the motor to a stop—the MM6 continued to run uninterruptedly until 15:36, when it was halted by increasing shade that overtook the table where the outdoor apparatus had been placed. The peak speed of this test was therefore reached at ca 10 minutes into it, when the ΔT attained 11°C. The appearance of clouds and haziness, combined with the progressively lower altitude of the sun in the horizon system as well as a greater atmospheric absorption with the passing hours, all combined to steadily lower the speed of the motor over the hour and a half of its continuous operation. Yet, the motor still managed to run from ΔT values as low as 5.6°C, at 24.4 rpm.

Photo by Eugene Mallove.

Stirling Engine mounted on HYBORAC

From a variety of other subsequent tests of the same motor at steady-state values of ΔT, the mean relation between ΔT fed from the To-T difference (measured at the HYBORAC top plate) of the HYBORAC to the MM6 motor, and the speed of the latter in revolutions per minute, is shown in Figure 2. The linear regression extrapolates through 4°C at what is likely the lower limit of motor speed at ca 20 rpm. The same slope indicates that with larger ΔT's, on the order of >20°C, it should be quite possible to achieve Stirling motor speeds of >80 rpm. The highest speed registered with our experimental arrangement was 57 rpm (not shown in Figure 2, but presented in our video demonstration[9]).

In all these tests, the temperature of the bottom plate reached peak values of 44.6°C, with a top motor speed of 53 rpm, and this corresponded to a cool-plate temperature of 32.1°C or a ΔT=12.5°C. Despite this astonishing success in our coupling of Stirling motors to the thermal anomaly of ORACs, the Carnot cycle efficiency of the entire assembly was merely:

$$[(T_H - T_C)/T_H]*100 = (\Delta T/T_H)*100 =$$
$$(12.5 \text{ Kelvin})/(317.6 \text{ Kelvin})*100 = 3.94\%$$

We know that this can be at least doubled to 8-10% by employing the full breadth of the To-T difference observed in the special "inverted-layer" BORACs, as we propose to do with our improved HYBORAC device, shown in Figure 3 and described in the Discussion section which follows below. Actual power output with this Stirling technology will still remain below Carnot by an amount that was not experimentally determined.

Finally, two types of controls were conducted with the same motor and mount, and on the same day as the first tests were carried out:

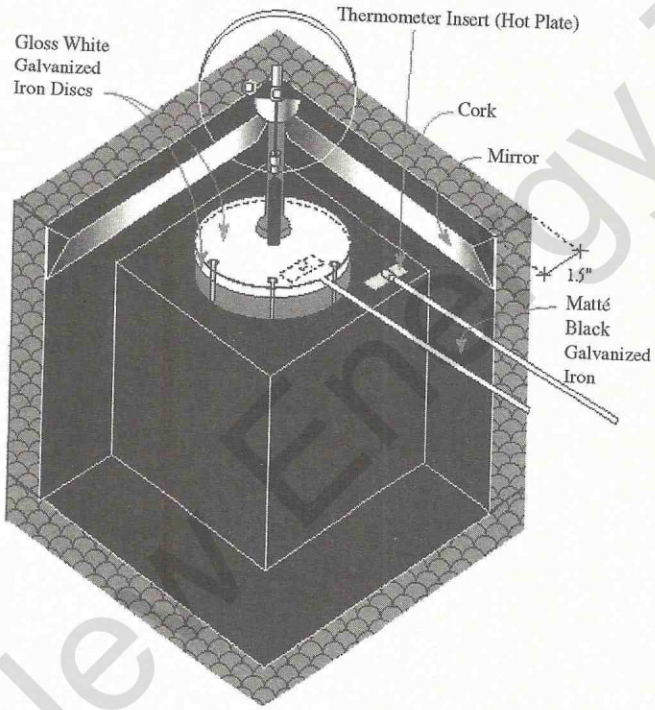


**Figure 3.** Final design of the improved HYBORAC. The upper cold plate of the Stirling motor is painted white and covered by another white painted plate placed ca 1 cm above it. The top plate of the HYBORAC functions as the hot plate of the Stirling motor. The adjustable concave mirrors are optional—they further improve the efficiency, but are not required. Mirrors could also be mounted on the bottom faces of the HYBORAC.

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1. With the top Stirling plate shaded, and the bottom plate on a matte wooden table exposed to the sun, the same motor failed to run despite repeated attempts carried out around noontime; hence the box volume was needed.

2. With the Stirling assembly mounted atop the naked Faraday cage, that is, without the other three BORAC sides, and with the top Stirling plate shaded, the device also failed to operate. This meant that the top plate of the cage (bottom plate of the Stirling motor) was neither uniformly heated, nor sufficiently warm.

Both controls indicate the need for mounting the motor assembly atop the volume of a modified ORAC.

**Addendum (November 20, 2001)**

In the wake of these experiments, the authors received another MM6 motor kindly provided by Dr. Mallove. The intended objective was to establish a set of controls with other arrangements. However, the second motor proved to perform much better, falling well within the standards of the manufacturer, the American Stirling Company—since it started moving at 3.2°C and often continued rotating with ΔT values as low as 2.2°C. We were therefore unable to proceed to a straight comparison between two motors under the same atmospheric conditions (eventually, as discussed in the companion report, we did just that, when Dr. Mallove supplied us with a third motor). We were able nevertheless to proceed to a comparison of the performance of eight different arrangements with the new, exquisitely sensitive motor (MM6-2). It was important to conduct the comparison at sensibly the same atmospheric air temperature, since we had already noted that starting up the Stirling motor does not strictly depend upon a minimum value of ΔT. Indeed, the value of $\Delta T_{min}$ was found to increase with decreasing air temperature during daytime. Likewise, the same motor speed required an increasing value of ΔT with decreasing atmospheric air temperature. Since we did not control for the intensity of solar luminance, we sought to unify the test conditions. This meant that we should carry out our outdoor comparisons under the same air temperature conditions (°9C was chosen), only on bright sunny days, and in the same daytime hours (13:00 to 14:00). All readings were taken at 30 minutes after exposure of the arrangements to solar radiation. All speeds were determined manually with a chronometer. The To values were measured on top of whatever surface the bottom plate of the MM6-2 was resting on, and the T values were read from an atmospheric control thermometer.

The comparison results are shown in Figure 4. Under arrangement 1, the MM6-2 was tested with its top plate shaded by an insulated plate covered on top with reflective aluminum tape, and the bottom plate was exposed to ambient air and in contact with two diametrically opposite flat wood supports (unvarnished). The lower plate temperature was read directly from the plate. The maximum ΔT registered was 0.5°C, and as shown in Figure 4, it could not start up the motor. Then the MM6-2 was tested on a square foot plate of varnished wood (arrangement 2)—with a ΔT of 7°C. The speed clocked after 30 minutes of exposure to the sun was 37±3 rpm (n = 3; [ΔT/(To-T)]*100 = 76.4%). Arrangements 4 and 5 employed, respectively, a 10"x10"x10" varnished pine box and an identical cubic foot pine box containing an 8"x8"x8" Faraday cage to form a simple 1x ORAC. As shown in Figure 4, with a ΔT of 7.3°C, the wooden box drove the Stirling at 60±2 rpm ([ΔT/(To-T)]*100 = 69.2%), and the 1x ORAC was rather comparable at 64.5±3 rpm with a lower ΔT of 6.15°C ([ΔT/(To-T)]*100 = 72.3%). It is also interesting to note that under clouded conditions (6.3°C air temperature), the wooden box ceased driving the MM6-2 with a ΔT of 2.65°C, while the 1x ORAC, under the same clouded conditions (6.5°C air temperature), could sustain rotation of the same motor at 21±3 rpm, with ΔT's as low as 2.2°C.

Arrangement 5 denotes the testing of a simple, reflective, galvanized iron (8"x 8"x 8") Faraday cage. With a ΔT of 7°C, the box drives the motor fastest at 82±6 rpm ([ΔT/(To-T)]*100 = 57%). Arrangement 6 is another control—a clear acrylic plastic box (7.5"x 8.5"x 9.5"), suggested by Dr. Mallove: the results indicate a very diminutive ΔT of 2.15°C ([ΔT/(To-T)]*100 = 71%), under the same conditions described above, and complete failure to start the motor. Since the final HYBORAC design called for the usage of a matte black half-Faraday cage, we

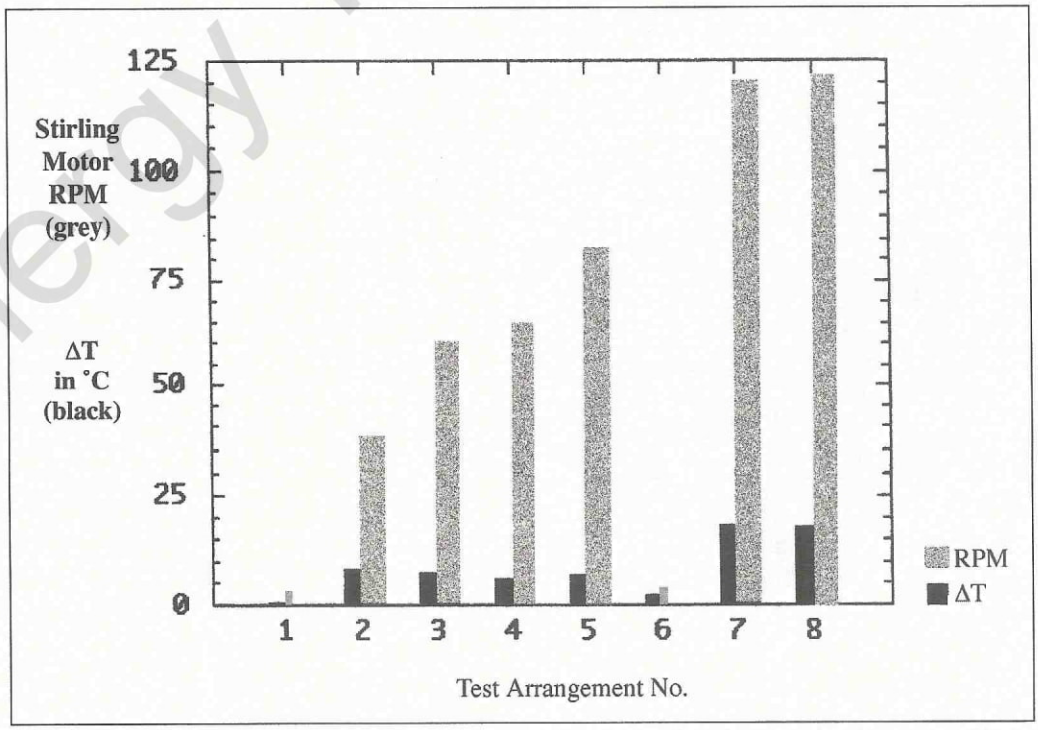


**Figure 4.** ΔT and MM6-2 rpm as a function of the arrangement tested outdoors, under direct sun, with air temperature of 9°C: 1. Motor control with bottom plate exposed to ambient air; 2. Motor on a flat sheet of varnished pinewood; 3. Motor atop a varnished pine box; 4. Motor atop varnished pine box encasing a Faraday cage (1x ORAC); 5. Motor atop a reflective Faraday cage; 6. Motor atop a clear acrylic box; 7. Motor atop a matte black Faraday cage; 8. Motor atop a matte black HYBORAC.

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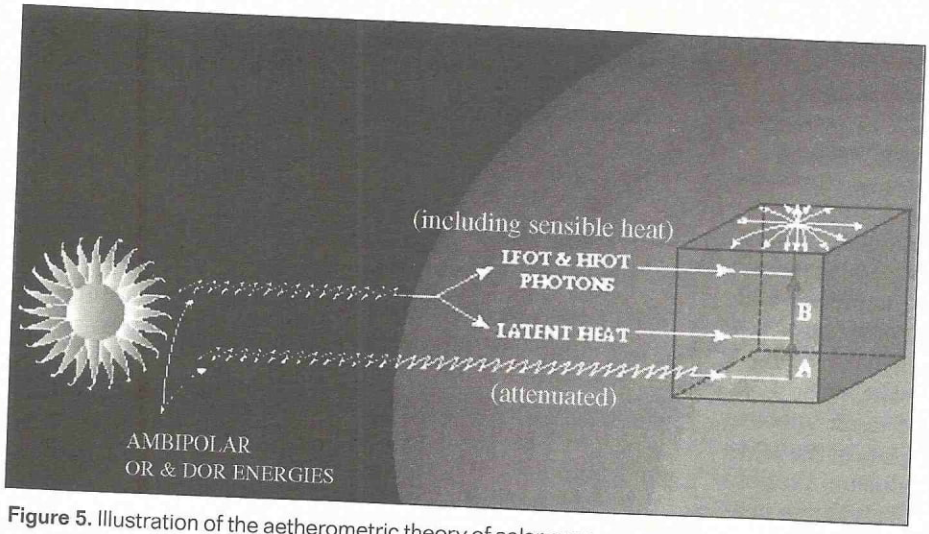


**Figure 5.** Illustration of the aetherometric theory of solar energy conversion: massfree electric aether energy radiated from the sun is converted into blackbody electromagnetic energy and latent heat by the terrestrial atmosphere. Both electromagnetic energy (including sensible heat) and latent heat are absorbed by ORACs. So is the attenuated ambipolar energy that reaches the terrestrial surface. The ORAC itself functions as a microatmosphere that transforms latent heat into sensible heat, and residual ambipolar energy into latent heat and ultimately into sensible heat. It is the integral sensible heat output from the top plate of the HYBORAC which is input to the Stirling motor.

tested, in arrangements 7 and 8, respectively, such a box by itself, and as part of the HYBORAC design. The observed increase in ΔT and MM6-2 speed is dramatic—and comparable for both arrangements: ΔT of 17.9°C ([ΔT/(To-T)]*100 = 85%) and 120±8 rpm for the black cage alone, and ΔT of 17.8°C ([ΔT/(To-T)]*100 = 72%) and 121±4 rpm for the HYBORAC. In comparison with the wooden box and the 1x simple ORAC, the increase is practically two-fold.

By themselves, these results do not yet demonstrate the superiority of the HYBORAC design over the simple black cage; from preliminary tests, however, we have noticed that the time of exposure to solar radiation that it takes to produce a substantial difference between the two arrangements is greater than 30 minutes, and nearer the 1 hour mark under the conditions chosen (including 9°C air temperature). For a 1.5 hour exposure, our initial results with the third Stirling motor (MM6-3) suggest the presence of just such a difference, as shown in Table 1 below, but it remains to be seen how significant it is:

**Table 1**

| | ΔT | RPM (n=3) | (ΔT/(To-T)]*100 |
|---|---|---|---|
| Black Faraday cage | 16.7 | 127±5 | 78.1 |
| HYBORAC | 21.15 | 146±7 | 66.3 |

The HYBORAC design, however, also has another advantage—increased heat retention—being capable of sustaining the Stirling motor action for 68 minutes after the disappearance of direct solar radiation, as opposed to the black cage, which only sustains the action for a scant 10 minutes.

## Discussion

Conducted in the early days of autumn, these tests demonstrate how the HYBORAC—a modified ORAC, which is half BORAC and half Faraday cage—can drive a low delta-T Stirling motor (MM6) by maximizing both the electromagnetic radiation that it absorbs locally and the amount of latent heat that it draws and holds, as studied in other reports.[7,8,10]

By itself, this irrefutable demonstration of free energy is not analytical proof of the existence of either orgone energy or latent heat. One can already hear the objections of mechanistic-minded scientists—"all you have shown is that you can drive a Stirling from solar radiation." That is right. But why the contempt or incredulity? Because what they mean is that all we have succeeded in doing with the preceding was merely to show that a matte black box, properly constructed, can maximalize the influx of solar electromagnetic radiation and convert it into heat. Here, however, is precisely where they are proven wrong by our own demonstration that the main modes of blackbody absorption for BORACs, or the measured rate of heat flow, cannot account for the heat radiated and trapped in these devices, even when they are "directly exposed to the Sun."[7] Moreover, as our theory proposes, there is no such hybrid in nature as electromagnetic radiation emitted from the sun. Aetherometry demonstrates that what traverses Space is not transverse electromagnetic radiation (and certainly not sensible heat), but longitudinal ambipolar electric radiation emitted from the sun. All that electromagnetic radiation consists of is a local production of photons (for those who care to listen: aether energy is not composed of photons, actual or virtual).

These are critical differences which lead us to propose a novel understanding of what exactly is driving that Stirling motor in the present experiments. Essentially, the HYBORAC maximizes sensible thermal output at its top plate, where ORACs and Faraday cages have been shown to evolve the greatest heat.[6,7,11] This sensible thermal energy reaches that top plate by a variety of processes, which are illustrated in Figures 5 and 6. Sensible thermal energy absorbed at the cage facets of the HYBORAC is conducted to the top plate and converted into greater kinetic energy and greater latent heat of the atmosphere inside the HYBORAC chamber; "latent heat" radiatively drawn into the box is also converted into sensible heat at the walls and the top plate of the device; and the attenuated ambipolar energy (ORgone energy) radiated from the sun that managed to penetrate through the local atmosphere is also drawn in and transformed into latent heat, further feeding its pool, and thus also the pool of sensible heat evolved above the top plate.

The threefold process is schematized in Figure 6. All three actions effectively combine to passively accumulate a surplus of sensible heat detectable on the ORAC top plate, and sustain therefore a viable Stirling motor drive through a setup that also demonstrates how the thermal anomaly of ORACs is ultimately and directly dependent upon solar radiation. It is solar radiation consisting of ambipolar OR (and DOR) elec-

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tric aether energy which is responsible for the local production of heat and light in our near atmosphere, as well as its "latent heat," by interaction with both leptons and hadrons. The HYBORAC exploits the natural synergy of these processes, to obtain To-T values of 10 to 20°C, that can be employed to drive a Stirling motor.

One way to improve the ΔT recovery of the full To-T difference that is possible to achieve with ORACs, is to paint the top plate of the MM6 white rather than black, and mount a second, slightly wider white plate ca 1-2 cm above it. The air space will permit cooling of the motor and the emplacement of the thermometer insertion pocket over the motor top plate, while shading the top plate from direct sun. This should result in better approximation of the temperature of the cold plate of the MM6 to the temperature of the control air-thermometer, possibly cooling the cold or top plate by another 5°C. This approximation will never be complete, since the cold plate is mounted above the hot plate and above the HYBORAC device. Even the temperature gradient of outdoor air will work against it. But these modifications to the engine will substantially improve the recovery of the To-T difference present in ORACs.

Likewise the three exposed facets of the 8"x 8"x 8" Faraday cage of the HYBORAC should be painted matte black (instead of being left as near-polished uncoated metal), while the other three sides could be made contiguous to the demi-BORAC. This simple modification will permit the HYBORAC device to achieve the >50°C registered by "inverted-layer" BORACs, thus extending the upper range of ΔT by another 10°C.

It is equally obvious that judicious employment of adjustable concave strip mirrors directed at the exposed facets of the semi-Faraday cage of the HYBORAC, including the top backsides, could further increase the temperature of the HYBORAC top plate.

With these final modifications to the HYBORAC and the Stirling motor, it should be possible to feed ΔTs of 20 to 30°C from nearly corresponding To-T values obtained by maximizing the direct capture and conduction of sensible heat, and the capture and conversions of latent heat and ambipolar OR energy.

**Aetherometry demonstrates that what traverses Space is not transverse electromagnetic radiation (and certainly not sensible heat), but longitudinal ambipolar electric radiation emitted from the sun. All that electromagnetic radiation consists of is a local production of photons (for those who care to listen: aether energy is not composed of photons, actual or virtual).**

Integration of the preceding results and suggestions leads to a new design for the entire apparatus, which could be easily produced as a kit—comprising the HYBORAC device with a swivel mount (for better orientation towards the sun) and the modified Stirling motor. This is depicted in Figure 3. It should be possible to deliver ΔT values of >25°C to the modified MM6 from these integral Sterling-HYBORACs capable of developing To-T values on the order of >30°C.

Scientists not familiar with microfunctionalist thinking will fail to grasp the functional identity of latent and sensible heat with respect to reflection, absorption, and concentration, as they do not realize either to be a byproduct of the interaction of matter with ambipolar radiation. The immediate response of conventional physicists and professional skeptics will be that the performance is explained by the absorption of solar radiation as sensible heat. The fact is that we ourselves do not disagree with this notion—not entirely, as the reader can see from the preceding. Nor was the point of the HYBORAC/Stirling experiments to provide a distinction between passive solar absorption and "orgone generation of sensible heat," and even less in a manner that excludes the former.

The objective of the experiment was to demonstrate that a Stirling motor can be run from the heat evolved atop a modified ORAC. That is all—since it is not an analytical experiment. We have already demonstrated[7,8] and feel no real necessity to have to re-demonstrate it again in the present context, that a significant portion of the sensible heat of ORACs results from the conversion of the latent heat they concentrate and which can be quantified electroscopically (and not from orgone directly). There is no visual way to demonstrate this with the Stirling motor, because it responds to the total sensible heat output, whether the device is in the shade or in the sun. Obviously, we do not regard the Stirling experiment as something that could stand on its own, in isolation from the rest of aetherometry.

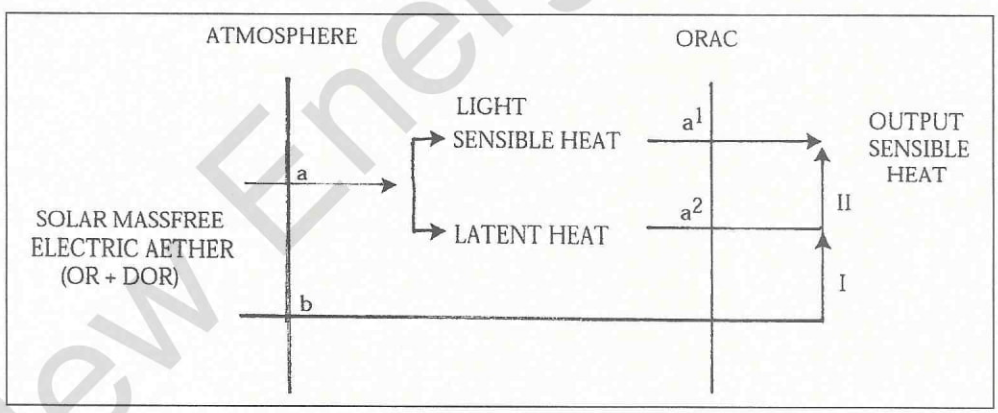


**Figure 6.** Schematic of the overall aetherometric conversion process of solar energy feeding the HYBORAC drive for Stirling engines. Massfree ambipolar energy radiated from the sun, and including OR and DOR energies, is either converted and split by the atmospheric envelope into electromagnetic energy (photons) and latent heat—through pathway a—to feed either sensible heat (path $a^1$) or latent heat (path $a^2$) to the HYBORAC, or is attenuated by the atmosphere (pathway b) and converted into latent and sensible heat by the HYBORAC. Essentially, the HYBORAC passively converts massfree ambipolar electric energy into latent heat, and latent heat into sensible heat.

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Nevertheless, we should mention that in the companion paper (which will be published in Issue 42) we will provide a method to drive the same Stirling motors from ΔT's generated by a modified ORAC structure during the nighttime period.

### Conclusions

Our findings constitute stark confirmation of the reality of the thermal anomaly originally discovered by W. Reich in ORACs, which he attributed to a conversion of solar-sourced OR energy into sensible heat. The thermal anomaly is illustrated most graphically by the ORAC's capacity to feed sensible thermal energy to perform the atmospheric (baroscopic) work exploited by the Stirling engine. This is stark and simple evidence of "free energy," or more properly, of a technological graft onto a flux of sensible heat ultimately derived from the aether radiation sourced in the sun, by a variety of conversions identified by the science of aetherometry and employed in the HYBORAC design. The results could be made still more graphic by employing an arrangement such that, with the sensitive Stirling motors employed, one might obtain continuous operation. This would effectively result in a perpetuum mobile driven courtesy of solar radiation.

### Acknowledgements

We wish to thank Dr. Eugene Mallove for having encouraged us to explore the Stirling motor coupling to the thermal anomaly of ORACs, for most dedicated support and the gift of three MM6 motors. We are also grateful for Mr. Jan Roos' careful coupling of the top plate of the Faraday cage to the Stirling motor. Lastly, we thank Dr. Malgosia Askanas for reviewing the manuscript and for reference research. Patent protection has been applied for.

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*Forthcoming in Infinite Energy Issue 42...*

## A Modified Orgone Accumulator (Complete Hyborac) as a Nighttime Drive for a Low Delta-T Stirling Engine

**— PART II —**

### Abstract

In a previous report (published here), the first of a two-part series, we demonstrated that it was possible to drive low delta-T Stirling engines of the MM6 type from the solar-sourced anomalous To-T difference registered in modified Orgone Accumulators referred to as HYBORACs, composed partly of a matte black-painted ORAC and partly of a Faraday cage. The design optimized response to solar radiation as well as heat retention, yielding motor speeds up to 140 rpm with ΔT's on the order of 21°C. In the present report, our focus lies in maximizing the HYBORAC structure so that it can sustain outdoor operation not just when exposed directly to atmosphere-filtered solar radiation, but above all during the nighttime hours when the device cools together with the cooling air and the absence of solar radiation. It should be noted that this is not simply a problem of maintaining a positive temperature difference (To-T), since the motor action continually pumps sensible heat out from the HYBORAC. But by increasing the retention of heat, we can also maximize utilization of the sensible heat being generated from other energy conversions occurring inside ORACs.

The solution lay in an arrangement that employs both the HYBORAC and inverted BORACs as components of a more traditional ORAC arrangement, into which they can be inserted. With this improved combination—referred to as the "complete HYBORAC"—we were able to achieve speeds of 150 rpm during daytime (with ΔT values reaching 22.5°C, and speeds of 30 to 80 rpm during nighttime (with ΔT values of 3.1 to 9°C). Maximum duration of Stirling motor operation with the complete HYBORAC was 399 minutes (nearly seven hours), frost effectively bringing the motor to a halt even in the presence of a suitable ΔT value (3.5°C). The To-T values measured at the top plate of the complete HYBORAC reached 32°C during daytime, with ΔT recovery efficiencies of 65 to 86%, whereas nighttime To-T values exceeded ΔT by no more than 2°C, and when they became smaller than the ΔT (with recovery efficiencies greater than 100%), the motor began to exhaust heat generation inside the complete HYBORAC. From that point until it stopped, nearly two hours elapsed.

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VERIFIED AT LAST:

# The Strange and Terrible Story of the Kensington Runestone

Jim Richardson and Allen Richardson*

*This article originally appeared in the August 15, 2001 edition of The Ripsaw News (Duluth, Minnesota), and is reprinted with permission of the authors. It recounts a battle for scientific acceptance against vicious attack, known all-too-well by new energy researchers.*
*—EFM*

The comfortable scientific and scholarly worlds of history, archeology, runology, and Scandinavian linguistics have all been rocked by recent developments surrounding a single stone in west central Minnesota.

The Kensington Runestone, thought for over 100 years to be a hoax, now stands verified as a genuine artifact commemorating the deaths of ten medieval Scandinavians in Minnesota in the year 1362.

A recent piece of linguistic scholarship by Dr. Richard Nielsen has hit the scene, which certainly seems to demonstrate conclusively that the Kensington Runestone inscription is genuine. Nielsen's 75-page paper took twelve years of research to write and was published in the spring 2001 issue of *Scandinavian Studies*, the peer-reviewed journal of Scandinavian linguistics.

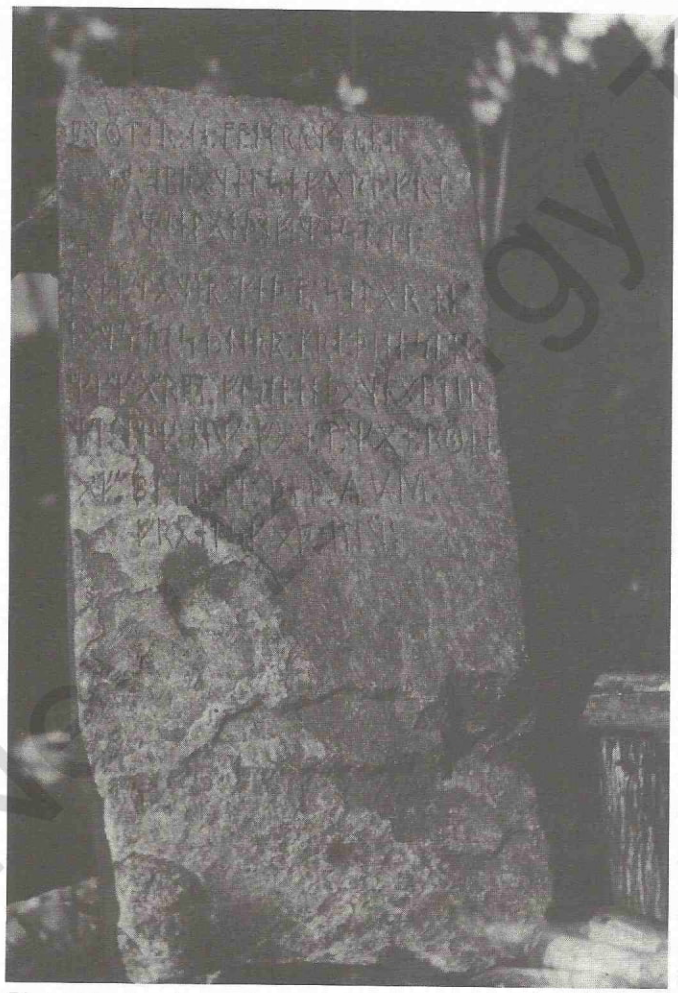

Photo: From the collections of the Minnesota Historical Society.

**Photo:** The Kensington Runestone, ca. 1920.

Nielsen's work has been joined by long-overdue scientific testing on the surface of the stone, coordinated by chemist and design engineer Barry Hanson.

Nielsen and Hanson's findings reveal more than just the authenticity of a runestone, however. Their work points plaintively at 100 years of scientific incompetence and knee-jerk skepticism regarding this valuable historic artifact. The shock waves are just beginning to reverberate through the scientific world.

### The Story of the Stone

In 1898, just outside of Kensington, Minnesota, farmer Olof Ohman found an intensely enigmatic artifact ensnarled in the roots of a tree. It was a large stone tablet, weighing over 200 pounds, and covered with medieval Scandinavian runes. The inscription on the stone, which now resides in a museum in Alexandria, Minnesota, reads: "Eight Goths and 22 Northmen are on this acquisition expedition from Vinland far to the West. We had traps by two shelters one days travel north from this stone. We were fishing one day. After we came home I found 10 men red with blood and dead. Ave Maria deliver from evils! I have 10 men by the inland sea to look after our ship, 14 days' journey from this island Year 1362."

Many features of the Kensington Runestone were so far outside the experience of the experts of the day that it was quickly branded a hoax. Ohman's life was never the same. His reputation was destroyed, and he and his family endured a virtual reign of terror that, arguably, helped drive his daughter to suicide. And the stone itself, like Ohman's reputation, has remained an object of derision ever since.

The reputation of Ohman (who died in 1935) seems to finally be cleared, but only after a terrible human cost was exacted upon him and his family. Olof's last surviving son is quoted by family friends as saying (in a 1995 interview conducted by Ove Pederson with Ione and Einar Bakke) that discovering the stone was the worst thing that ever happened to the Ohman family.

A long line of scholars examined the stone's inscription and saw unfamiliar runes, grammatical structures, and numerical notations, and nearly everyone loudly pronounced the stone a fake, and a poor one at that. Such words were impossible for the fourteenth century, they said. However, the unknown numbers, letters, words, and sentence structures ascribed to Ohman's criminal genius began to turn up in authenticated Scandinavian texts almost immediately after the stone's discovery. Indeed, several "unknown" runes had turned up even *before* the stone's discovery, yet went completely unrecognized by the top scholars of the day.



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If the experts had done the proper research at the time, the stone could have been well on its way to authentication. Ohman's reputation and family could have been saved. Instead, the story of the discovery of the Kensington Runestone, America's first known written document, will go down in the annals of linguistic shame.

**How It Happened**

Olof Ohman was a man with thirty-six weeks of education, nine children, and a marginal farm. Hanson wrote in his book *The Trail of Olof Ohman,* "Olof Ohman's character, after endless scrutiny by people who were trying as hard as they could to show the KRS as a modern forgery, survives unblemished. Every person who knew Ohman said the same thing; he was honest, he was honorable, and he would not or could not have carved the inscription, nor would he lie to his sons as part of any conceivable activity he might be engaged in." And yet this unlikely hoaxer got stuck with the reputation of perpetrating a brazen fraud. How did it happen? What was the case against Olof Ohman and the stone, and how did the notion of a hoax falsely perpetuate itself for so long?

The case against the authenticity of the stone was primarily made using linguistic arguments. It is not too far off the mark to suggest that the way the linguists handled the case of the Kensington Runestone provides a study of how not to approach a scientific anomaly. The geological analyses of the stone have always supported its medieval pedigree, with the geologists in question always adopting a "wait and see" attitude toward the disputed runes. As we now know, this was apparently the correct approach.

Thirty-two experts in Scandinavian linguistics have declared the Kensington Runestone inscription fraudulent over the past 100 years. Ten of those experts actually published papers and/or books about the stone. One thing that helps explain their stunning collective failure is that most of them hailed from the small, closed, conservative world of European linguistics. When seen from this stodgy milieu, the stone was nothing short of an outrageous affront. In addition, at the time the stone was found, the linguistic study of medieval runology was actually a fairly young science, and in many ways, woefully incomplete. Looking back on it now, this is obvious, as the past 100 years have seen developments in the field that, perhaps, could not have been anticipated back then. For instance, old manuscripts have been continually uncovered, yielding previously unrecognized medieval runeforms, words, and elements of grammatical style. There are still piles of medieval writings that present day scholars have not even been able to get around to studying yet. However, in 1898, the most accomplished experts of the day were at the pinnacle of their profession. And no stone from America could tell them otherwise.

The Kensington Runestone contains 23 different runic letters (or "runeforms"), which are used to write an inscription of 46 words and 7 numbers. Eleven of the runeforms, and more than a dozen of the words, were unknown to the experts of 1898. In addition, the numbers on the stone failed to conform to the proper notation conventions as they were then known. For these and other reasons, time and time again, the case was made for fraud. Once the first couple of investigators had proclaimed the stone to be a forgery (and they weren't even experts, see sidebar), it seems as if the taint of scandal became so intoxicating to the academic community that the stone simply couldn't get a fair hearing for the hysteria. Once it was "known" to be a hoax, whole reputations and careers were made by trashing the stone and its few defenders.

The way the Kensington Runestone, and Olof Ohman, became objects of scorn says more about the psychological opposition to fresh ideas than about the proper conduct of science. The way some of the experts comported themselves, in the face of the unknown, does a disservice to the ideals of the scientific method. Personal attacks took the place of data collection. Sloppy scholarship and unreferenceable claims became the order of the day. Invoking "the experts" took the place of doing actual research. The general attitude toward the Kensington Runestone was one of contempt, as evidenced by Professor Jon Helgason's remark to Kensington Runestone "debunker" Erik Moltke which Moltke quoted in a 1951 article for *Antiquity* magazine: "In my opinion the inscription on the Kensington Stone is such that no philologist with any self respect could in any decency write about it." The stone posed an effrontery to these men's sense of expertise, and Moltke's contempt for the stone was as great as Helgason's. But rather than thrusting his nose up in the air and ignoring it, as Helgason deemed to be the proper response, Moltke expressed a more aggressive opinion as to how one should approach the anomaly. "There has been so much fuss made about this inscription that a stop must be put to it," Moltke wrote.

Sloppiness and hubris pervade the quality of scholarship that the stone has been subjected to through the years. In his zeal to "put a stop to it," Moltke resorted to some extremely heavy-handed rhetoric, as when he wrote of the stone in 1949, "See what an abortion it uses as an *a*-rune." In addition, Moltke claimed that the *n*-rune had gone out of use by 1100 and that was reason enough to declare the Kensington Runestone a forgery. But the *n* runeform as shown on the stone was later discovered to have been in use well into the fourteenth century, as documented by various scholars since J.E. Liljegren found one in 1832. When this information became known, both Moltke and another skeptic, Sven Birger Frederik Jansson, quietly dropped it from their list of complaints. As for the *a* runeform, it is found on the Lye Church inscription from medieval times on the island of Gotland.

So many of the runes, flatly declared to be "impossible" in 1898, could have been found with a little research. The runes in question simply hadn't made it to the runic dictionaries yet, but they each existed in referenced works, and in principle, they could have been found. Simply put, the Kensington Runestone was never seriously studied by those most qualified to do so. It was merely written off, when in reality, it had much to teach. It is hardly an exaggeration to suggest that if the stone had been subjected to serious scrutiny, and authenticated in 1898, it would have advanced our knowledge by 100 years in the fields of Scandinavian linguistics, runology, history, and the archeology of North America. As it stands, some doors in these fields are only now beginning to open, but the keys have been available for four generations.

A case in point: one of the most prominent Scandinavian linguistics texts cited in the Kensington Runestone controversy was *Old Swedish Grammar with Inclusion of Old Gotlandic,* published by Adolf Noreen in 1904. Moltke, and others, heavily utilized Noreen's text to "debunk" the stone in a series of articles in various scholarly journals. However, whereas Noreen's book was "a monumental achievement for its day," according to Einar Haugen and Thomas L. Markey's 1972 book *The Scandinavian Languages: Fifty Years of Linguistic Research* (1918-1968), it "has not been reprinted since it first appeared

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and, as many texts not readily accessible to Noreen and his readers have been published subsequently, it is badly in need of revision."

Of course, in fitting with the overall pattern of the Kensington Runestone story, Moltke became one of the prime "experts" invoked by others as they dismissed the stone, even though he had used Noreen's outdated linguistic text from 1904 as the basis for his own conclusions made as late as the 1950s. This is currently cause for no small degree of embarrassment in scientific circles, as anyone who ever built a house of cards against the Kensington Runestone, in part by citing Moltke's (and others') "expert" work, now finds themselves on the wrong side of the issue, and their arguments hopelessly outdated.

Many of the claims made against the inscription on the stone appeared in the form of unreferenceable claims, which often take the form of something like, "This word is impossible for the fourteenth century." Stated authoritatively by an "expert," this type of claim appeared to carry weight, and inevitably became cited by others in lieu of citing actual data. This is why Nielsen's paper is considered so significant. It represents the only comprehensive paper on the language of the Kensington Runestone yet published in a serious professional journal. Each claim is referenced, and each bit of data has been verified by the reviewers.

When it was discovered that Ohman owned a couple of books that contained runes, the experts went wild. Here was the clincher for them. The books, each published in Stockholm in the late 1800s, were *The Well-Informed Schoolmaster* by Carl Rosander and *Sweden's History From the Earliest Time to Our Time* by Oscar Montelius. It was claimed that Ohman had used these books as the source material for his hoax. However, as is the case with so many other arguments leveled at Ohman and the Kensington Runestone, the accusation that he used these books was never seriously investigated, but merely thrown onto the pile of already-existing accusations. If the issue had been seriously looked into, it could have been easily exposed as an impossibility. The runes available to Ohman from the Rosander and Montelius books account for only half of the runes on the stone. And of the remaining runes, many of them were unknown to anyone in 1898; not just to the uneducated farmer, but to the most educated Scandinavian linguists in the world.

**"Death Bed Confession"**

Then there is the case of the so-called "death bed confession." While it has done much to prejudice the public against the stone's authenticity, it is quickly revealed to be the only real hoax of the entire Kensington Runestone saga.

In the late 1800s there were some neighbors to the north of the Ohman farm by the name of the Gran family. In 1967, Theodore Blegen, one of the arch-nemeses of the stone, persuaded a nephew of Walter Gran to do an audiotaped interview which became known as the "Gran tape." Gran was four years old when the stone was unearthed, so he didn't remember much about those days. But he did manage to spin a tale, on the taped interview with his nephew, about how his father, John Gran, made a "death bed confession" in 1927 (forty years before the interview). The "confession" allegedly concerned Ohman forging the Kensington Runestone.

The story was published in 1976, in a series of articles in *Minnesota History* by Russell Fridley, director of the Minnesota Historical Society. The BBC even got in on the act when it used the "confession" as part of a documentary about the Kensington Runestone "hoax." The trouble is, the spectacular "death bed confession" is neither.

John Gran was not on his death bed when he allegedly uttered these things. Walter Gran said that John Gran's death bed confession happened in 1927, but John Gran did not actually die until 1933, six years later. Some death bed!

There is not even a confession: Walter alleged on the tape that his father said, "Go ask Ohman," and then when Walter did so, Ohman said essentially nothing.

The so-called "Gran tape" contains nothing of scientific value that bears upon the authenticity of the stone. Somehow the myth of it has grown to include a death bed confession, when really there is only innuendo.

Compounding the issue, Walter Gran's very truthfulness was not given glowing endorsements by his friends and neighbors in subsequent interviews with them. One of them said in a 1979 interview with Ted Stoa of Fargo, North Dakota, "I didn't take too much stock in what Walter said at times." This same sentiment was echoed by Iona and Einar Bakke in a 1995 interview conducted by Ove Pederson.

The Gran tape struck a particularly unscientific blow against the authenticity of the stone. As the story blossomed, the unfinished science of the stone became overshadowed with gossip.

**Authentication**

The "unknown" runes, words, grammatical quirks, and numerical notations of the Kensington Runestone have all since turned up in medieval Scandinavian texts. What has been needed for some time, in order to settle the issue, is for someone to put it all in one place for the world to see. This has finally happened, and all of it has been extensively documented. Nielsen's article seems to sound the death-knell on the case against Ohman and the Kensington Runestone.

Hanson also has played no small role in the authentication of the stone, complementing Nielsen's linguistic work with some impressive scientific studies. Interestingly, of the scant few in the Kensington Runestone debate who have come down on the side of the stone's authenticity, it was mostly those citing geological concerns. The geologists looked at the stone and said, in effect, "This thing's ancient! There's no way it could be a modern forgery!" The linguists never paid them any mind, and if they did it was to ostracize them and to minimize the geological evidence. Geological considerations have supported the stone's great antiquity since N.H. Winchell, state geologist of Minnesota, and others (including the state geologist for Wisconsin) first examined the stone in the early 1900s.

Since that time, however, the linguists have dominated the debate and successfully marginalized the issue of the stone's geological features. That is until Hanson came along and wondered: what has been discovered upon examining the stone with a microscope? To his amazement, he learned that no one had ever attempted it. For that matter, no one had ever so much as *recommended* that this basic piece of science be conducted.

Hanson realized that this represented a huge gap in the history of the Kensington Runestone controversy, and got to work. First, he published his recommendations for physical testing of the stone in the winter 2001 issue of the peer-reviewed history periodical *Journal of the West*. Then, having been granted exclusive authority by the owners of the stone to



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coordinate its scientific testing, Hanson contacted various people in the fields of geology, chemistry, and geophysics. Work was initiated by Scott Wolter at American Petrographic Services in St. Paul and continued at the University of Minnesota Department of Geophysics, where an electron microprobe analysis was conducted on parts of the surface of the stone. American Petrographic Services oversaw the conducting of some scanning electron microscope work at Iowa State University on the same samples. The investigations are just beginning, but the initial results indicate that the original geological assessments of the Kensington Runestone by Newton Winchell in 1909 are correct. In other words, the stone is authentic, and it had been in the ground many decades before Olof Ohman moved onto his land near Kensington.

**Skeptics Slow to React**

Among longtime Kensington Runestone skeptics, the reaction to Nielsen's May 2001 paper (and its supporting evidence from Hanson's testing) has been slow in coming. There are rumors that some have started to turn, and a couple of them have dug in their heels, but for the most part, a great silence wafts over the critical landscape. What are we to make of this silence?

Hanson is arguably in the best position to understand the skeptical reaction, since his book, *The Trial of Olof Ohman*, examines every skeptical word ever written about the stone. As Hanson sees it, part of the problem in getting a quick reaction out of the ten or so most prominent Kensington Runestone skeptics is that Nielsen's paper went further in tracking down dozens of medieval source documents than any scholars had ever done before. These documents include diplomas, letters, law codes, and various legal and official documents. Hanson explains, "No one, living or dead, has ever studied or even is aware of, in most cases, these critical documents. Without them one has no basis to comment on the KRS language." And therefore, it seems, no one is.

There is also the matter of the peer-review process, which has taken the Kensington Runestone controversy to a new level. Much of the controversy has played out over the years in popular books and magazine articles, where assertions do not have to be rigorously double-checked and scrutinized. By publishing in the peer-reviewed Scandinavian language journal *Scandinavian Studies*, Nielsen now has the high ground. Reviewed by, among others, Prof. Michael Barnes of University College (one of Europe's foremost experts in Medieval Scandinavian and runology and Secretary of the Viking Society to boot), Nielsen's paper essentially has the blessing of some of the establishment. Before Nielsen's paper, it may have been a little easier to take potshots at the stone and its defenders. But the playing field has changed, and the skeptics must now find it necessary to go through a more rigorous process in order to properly attempt an answer to Nielsen's evidence. No wonder the skeptical reaction has been muted. *Scandinavian Studies* has put the paper on their website to elicit discussion.

The Kensington Runestone, ghettoized for so long, is officially playing with the big boys.

**The Tip of the Iceberg**

What are the implications of an authenticated Kensington Runestone? What new avenues of discovery have been blown open by this scientific blockbuster?

Whoever the carver was, he was part of an "acquisition expedition" of eight Goths and twenty-two Northmen from the year 1362, smack dab in the middle of the North American continent. The Goths would have been from what is now western Sweden, and the Northmen could have been from anywhere else in Scandinavia.

In his article in the *Journal of the West*, Hanson, building upon previous work by Nielsen, speculates that the origin of the expedition may actually be related to the strange disappearance of a settlement in Greenland over 600 years ago: "It is known that the Western settlement in Greenland had a bad series of winters starting in 1308. . . In 1341, the settlement was discovered gone by Ivar Bardson, the bishop at Gardar in the Eastern settlement. There was no sign of violence or devastation; there were even some stray cattle roaming around. Some 1,500 people simply left in their boats, with many of their possessions. No one knows where they went, but it is suspected that these same people regularly visited the Ungava Bay area for wood, caribou and fish. They also probably were familiar with the Hudson Bay area, because there is evidence that they were at the Chesterfield inlet for iron and other parts of the Bay for polar bears and eider down. Based upon the types of fur they are known to have, it is strongly suspected that these Greenlanders traded with the natives of the region. . .Travel up the Hayes or Nelson rivers would be quite possible for the 'Greenlanders.'"

When asked to speculate further about the people who carved the stone, Hanson explained that his guess is that "they were from mainland Europe but associated somehow with the Greenlanders that had migrated from the abandoned Western colony. . .There most likely was an existing population of (the Greenlanders) in the area of the stone. Other artifacts including two boat hulls have been reported in this area, at approximately the 1,370-foot elevation. . .1,370 feet is the same elevation as remnant shore erosion features at KRS hill (water levels used to be higher in the area and KRS hill used to be an island). I think they took their time doing the stone. The KRS hill maybe was the 'home base.'" Hanson thinks that other artifacts will be found in the vicinity of Kensington Runestone hill and possibly to the east a few miles.

Is there any other existing evidence to support this new view of early European penetration into North America? In addition to the reports of actual ancient boat hulls mentioned above, there is a plethora of hitherto unacknowledged artifacts that may soon be getting a second look in the wake of the stunning resolution to the Kensington Runestone controversy.

For instance, there are the triangular holes of the Whetstone Valley in South Dakota and many more in western Minnesota. These consist of hundreds of unexplained triangular holes, 5 to 7 inches deep, in large rocks all across western Minnesota and northeast South Dakota. They do not appear to be blasting holes made by pioneers. Could they be mooring holes?

There are also the so-called Chippewa Valley axes, periodically plowed up out of virgin soil. Mostly in the hands of private collectors, these ax-heads could represent medieval-era, hand-forged, pre-crucible steel, and have no known counterparts in any mainstream American museum. At any rate, they have never been properly identified or studied.

There are also what appear to be habitation sites, discovered two or three feet underground via the remote sensing emitted infrared technology developed by Marion Dahm of Chokio, Minnesota.

And lastly, of course, there are about half a dozen other runestones. They are all smaller and less well known than the Kensington Runestone. But after what happened to Olof Ohman, is it any wonder that the discoverers of these other

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stones might have chosen silence, instead of scrutiny? (As this article was going to press, the discovery of another runestone was announced. Dubbed the "AVM stone," it was found within a quarter-mile of where the Kensington Runestone was found.)

**The Kensington Runestone and Erik's Chronicle (1330)**

Dr. Richard Nielsen, the man who finally cracked the case of the Kensington Runestone, did it in part with the help of a fourteenth century tale of knights in shining armor known as *Erik's Chronicle* (or *EK*, an abbreviation of the Old Swedish title, *Erikskrönikan)*. Nielsen's paper on *EK*, "Compliance of the KRS Language With That Shown in *Erikskrönikan*," is being published for the first time in Hanson's book *The Trial of Olof Ohman*.

Nielsen was well on his way to authenticating the long-dismissed language of the Kensington Runestone after he made a singular observation: "No investigator has attempted to identify an Old Swedish document that best reflects the language of the KRS. *EK* seemed like a good candidate owing to its length of 4,560 lines that perhaps contain over 25,000 words."

The seemingly massive job of studying the nineteen manuscripts that comprise *EK* was made somewhat easier by the extensive studies that had already been done. A scholar named G.E. Klemming had translated *EK* over a period of three years in the late 1860s. Then it caught the attention of Rolf Pipping, who used *EK* for his Doctoral thesis in 1919. That same year, Pipping went on to publish an index of every single word in *EK* complete with line number. As Nielsen wrote, "This makes *EK* extremely handy to study."

Contrary to the Scandinavian language experts (who have dismissed the "impossible" language of the Kensington Runestone up to the present day), the great majority of the linguistic features of the stone can be authenticated from this single fourteenth century tale. In fact, Nielsen wrote, "Differences between KRS and *EK* are slight and not many, and the KRS in each case is directly confirmed from other (medieval Swedish) sources."

The upshot of Nielsen's discovery is: the Kensington Runestone controversy need not have raged past 1919, when anyone involved could have picked up Pipping's index. If they had, they could have verified the vast majority of the stone's medieval language in a single stroke.

That would have meant a lot to Olof Ohman, the poor farmer who unearthed the stone. When Ohman died in 1935, Pipping's index had existed for sixteen years, yet Ohman still had not shaken his reputation as the forger of the Kensington Runestone. Pipping's *EK* index would have belied the accusations against Ohman, namely that he fabricated this or that word, rune or piece of syntax. How could Ohman have made them up if they were in use almost 600 years previously?

Nielsen shows how easy it would have been to verify the stone, and to redeem Ohman while he was still alive. Instead, the "experts" rejected the Kensington Runestone out of hand, instead of studying "the Scandinavian material at their fingertips."

By way of examples, the following are some of the linguistic features of the Kensington Runestone that have been cited as definitive proofs of a forgery, and how they have been laid to rest.

*Case Management*

The supposedly incorrect use of case in the Kensington Runestone is often cited as proof that the inscription was the result of not just forgery, but a somewhat unsophisticated forgery. However, Nielsen has brought to light, via *EK*, that the issue of case in this period of the Middle Ages is more complex. He explains, "The KRS is written in Old Swedish, which during the thirteenth century underwent a rapid readjustment of its complicated case system. This case system had to manage four declensions. . .In addition there were three genders. . .in both singular and plural. This means there were 24 different cases in all. . .What makes the thirteenth century so interesting to study is its record of dissolution of these cases. Opponents of the KRS like to take a classical stance with no dissolution of case, but this is not the situation that faced a scribe in 1362." Essentially, the Kensington Runestone experts have failed to recognize the difference between the most formal style of Old Swedish, used for, say, legal documents, and the language as it was actually used day to day.

Photo: From the collections of the Minnesota Historical Society.

**Photo:** Edwin Bjerklund (left), Olaf Flaaten, and Olof Ohman (right), at the Kensington Runestone discovery site, ca. 1910.

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# A Partial Chronology of the Kensington Runestone

**1362**
The stone is erected by medieval Europeans on an expedition to the center of North America. The inscription was probably carved by a priest from the Swedish island of Gotland, who was also familiar with the law codes of Vastergötland.

**1820-1880**
Numerous unusual runeforms are discovered and documented by various linguistic scholars. These same runeforms, when later discovered on the Kensington Runestone, are declared "impossible" by various "experts" in their debunking of the stone, even though the discovery of these runeforms predates the discovery of the Kensington Runestone itself.

**November 1898**
Olof Ohman and his ten-year-old son Edward are winching over trees to clear their land in Kensington, Minnesota. They unearth the stone. It spends its first couple of months displayed in a bank window.

**January 1899**
A translation is attempted, by Olaus Breda at the University of Minnesota, from a hand-rendered copy of the inscription. Although he never sets eyes on the stone, and states that he is not an expert in runology or the language of Old Norse, Breda yet comes to the conclusion it is a forgery. He makes his recommendation to the University: do not procure the stone for further study. He is later cited as an expert.

**February 1899**
The stone is sent to George Curme, professor of Old German at Northwestern University. Curme, and his amateur geologist associate John Seward, study the stone for several weeks. Curme states that although he is not an expert in the language or the runes, his opinion is that the stone is a hoax because it contains double dots (similar to umlauts) over a few of the runes, and the invention of umlauts came after the date on the stone. Curme is later cited as an expert. It is eventually discovered that double dots were a medieval convention indicating vowel lengthening or insertion of a letter. For his part, Steward observed that the carved out features of the Kensington Runestone showed as much age as the weathered surface of the stone. This is what is expected from a stone that has been hewn out of a rock and then carved; the rock's surface and its inscription have been exposed to weathering for the same amount of time. Steward's observation is ignored by future skeptics.

**March 1899**
The stone is returned to Ohman. It languishes in his shed for several years.

**August 1907**
A University of Wisconsin historian, Hjalmer Holand, becomes aware of the stone, studies it, and concludes it is a genuine medieval artifact. Over the years Holand clashes bitterly with the establishment over the authenticity of the stone.

**July 1909**
Ohman, his son Edward, and several neighbors all give signed affidavits stating the circumstances of the stone's discovery, the weathered and aged appearance of the inscription, and the way the roots of the tree had grown around the stone "in such a way as to exactly conform to the outlines of the stone" (affidavit signed by Ohman neighbor Nils Flaten on July 20, 1909).

**1910**
The Minnesota Historical Society designates a committee to study the stone. The committee's study, based on both language and the geological features of the stone, concludes that the stone is authentic. However, there is some dissent among the membership and the trustees over the issue, and prominent members of the Minnesota Historical Society publicly dismiss the stone many times over the years, continuing to implicate Ohman in the process. The Illinois State Historical Society issues a twenty-page report claiming the stone is a "modern inscription." The report stops short of implicating Ohman as the carver.

**Summer 1911**
Holand takes the stone to Europe to have it examined by Scandinavian language experts. Their conclusion: it is a fake. The stone is also exhibited in several U.S. cities.

**1929**
Harold S. Langland, president of Stanley Ironworks in Minneapolis and trained in the physical sciences, studies the stone for two months and concludes it is authentic because the carved out parts are just as weathered as the rest of the surface of the stone.

**1935**
Olof Ohman dies.

**Early 1940s**
The managing editor of the *Minnesota Archeologist*, R.H. Landon, Ph.D., has the stone coated with engine oil and scrubbed with a powerful solvent, in an attempt to "clean" it. No one knows how much damage this may have caused to the testable features of the stone's surface.

**August 1967**
The infamous "Gran tape" is made, recording an interview with Walter Gran, wherein it is alleged by many that Gran claims his father, a neighbor of the Ohmans, "confessed" on his "death bed" that Olof carved the stone. There is no actual confession related on the tape.

**1963**
Hjalmar Holand, one of the few lifelong defenders of the stone, dies.

**1968**
Theodore Blegen, who had initiated the making of the Gran tape above, publishes a book "debunking" the Kensington Runestone. The book alludes to a scandalous tale on the Gran tape, and helps to cement Ohman's reputation as an unscrupulous forger.

**1973**
The BBC films a skeptical Kensington Runestone documentary which leans heavily on the bogus Gran tape as its source.

**1976**
The director of the Minnesota Historical Society, Russell Fridley, publicizes the Gran tape in his articles in *Minnesota History*.

**2001**
After raging for years, the controversy is settled by the linguistic scholarship of Dr. Richard Nielsen, and simultaneously, by the scientific studies spearheaded by Barry Hanson, in concert with American Petrographic Services of St. Paul and scientists at the University of Minnesota's department of geophysics.

**Recommended Reading**
Richard Nielsen's paper, "Response to Dr. James Knirk's Essay on the Kensington Runestone," is the first comprehensive treatment of the language of the stone to be published in a peer-reviewed journal. It may be found at the Society for the Advancement of Scandinavian Studies' website, byu.edu/sasslink/. Click on minimum graphics, then *Scandinavian Studies* in italics, then go to supplemental material

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*Singular Verbs in Plural Function*

The fact that singular verbs in the Kensington Runestone inscription were used with plural nouns has been pointed out among the skeptics as proof of a clumsy forgery, for surely no actual speaker of Old Swedish would fall prey to this confusion. However it is not a case of confusion at all but merely that, like case management, the plainspoken language of 1362 was different than its most formal written counterpart (the version known by most Kensington Runestone skeptics). As Nielsen wrote, after citing sixteen examples from *EK* alone, "The singular verbs in plural function on the KRS are in keeping with the spoken language of 1362 and certainly can not be considered to be proofs of forgery."

*Umlauts*

This is the one that started it all. Professor George Curme, one of the first people to examine the inscription, rejected its authenticity based on the fact that it contained double dots over some runes, which he construed to be umlauts. Since umlauts were not invented until the sixteenth century, he announced the stone was a fake. However, double dots in the fourteenth century were not umlauts at all but indicated vowel lengthening or the insertion of a letter. As Nielsen wrote, "Clearly, Prof. Curme got the investigation off on the wrong foot."

*The Painful Birth of New Paradigms*

In the book *The Art of Scientific Investigation,* first published in 1950, author W.I.B. Beveridge describes many of the elements seen in the recently resolved Kensington Runestone affair. Beveridge's book anticipates Kuhn's treatment, decades later, of the painful birth of new paradigms.

Beveridge writes, "There is in all of us a psychological tendency to resist new ideas. . .just as there is a psychological resistance to really radical innovations in behavior or dress. It perhaps has its origin in that inborn impulse which used to be spoken of as the herd instinct. This so-called instinct drives man to conform within certain limits to conventional customs and to oppose any considerable deviation from prevailing behavior or ideas by other members of the herd. Conversely, it gives widely held beliefs a spurious validity irrespective of whether or not they are founded on any real evidence." (Beveridge, 1957 ed., p. 146).

Beveridge quotes Wilfred Trotter, who wrote in his *Collected Papers:* "The mind likes a strange idea as little as the body likes a strange protein and resists it with similar energy. It would not perhaps be too fanciful to say that a new idea is the most quickly acting antigen known to science. If we watch ourselves honestly we shall often find that we have begun to argue against a new idea even before it has been completely stated."

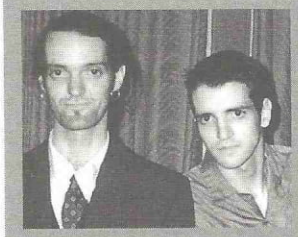
Recall the conversation between Professor Jon Helgason and Eric Moltke, where Helgason claimed of the Kensington Runestone that "no philologist of any self-respect could in any decency write about it," and Moltke's considered response that, instead, "a stop must be put to it." Beveridge addresses these men's respective reactions: "When adults first become conscious of something new they usually either attack or try to escape from it. This is called the 'attack-escape' reaction. Attack includes such mild forms as ridicule, and escape includes merely putting out of mind" (Beveridge, p. 147). Helgason exemplifies the escape reaction by having the "decency" to ignore the Kensington Runestone. Moltke, on the other hand, embodies the attack reaction, trying to kill the new ideas represented by the KRS, by "putting a stop to it." He conforms to Beveridge's model to the point of stooping to ridicule, as when he compared the *a*-rune of the Kensington Runestone to "an abortion."

Another aspect of the Kensington Runestone controversy is touched on by Beveridge in a quote he pulls from an essay by F.C.S. Schiller: "One curious result of this (mental resistance to new ideas), which deserves to rank among the fundamental 'laws' of nature, is that when a discovery has finally won tardy recognition it is usually found to have been anticipated, often with cogent reasons and in great detail" ("Scientific Discovery and Logical Proof" in *Studies in the History and Method of Science,* 1917, ed. by Charles Singer). In the case of the Kensington Runestone there are the many instances of previously known, studied, and referenced words and runeforms that were dismissed as impossible when they were found on the stone. In accordance with Beveridge's analysis, the language of the Kensington Runestone can thus be said to have been anticipated, and studied in great detail, long before the discovery of the actual stone, and its subsequent rejection.

Since the Ohman family suffered so terribly as a result of stumbling across the Runestone, it is tempting to condemn the many individuals who prematurely rushed to judgement. These are the people who sealed the Ohmans' fate. But Beveridge sounds a note of caution before we turn the tables on the skeptics. The rejection and "debunking," which plague such discoveries as the Kensington Runestone, can be understood as part of an inevitable, tragic process: "In nearly all matters the human mind has a strong tendency to judge in the light of its own experience, knowledge and prejudices rather than on the evidence presented. Thus new ideas are judged in the light of prevailing beliefs. If the ideas are too revolutionary, that is to say, if they depart too far from reigning theories and cannot be fitted into the current body of knowledge, they will not be acceptable. When discoveries are made before their time they are almost certain to be ignored or meet with opposition which is too strong to be overcome, so in most instances they may as well not have been made. Dr. Marjory Stephenson likens discoveries made in advance of their time to long salients in warfare by which a position may be captured. If, however, the main army is too far behind to give necessary support, the advance post is lost and has to be re-taken at a later date" (Beveridge, pp. 144-145).

We are left with the disquieting conclusion that the harassment visited upon Olof Ohman and his family, at the height of which his daughter committed suicide, was the natural result of a quirk in the practice of science.


**About the Authors**



Jim Richardson and Allen Richardson are the brother team behind the "Gonzo Science" column, published by the *Duluth Ripsaw News* (http://www.ripsawnews.com) and the web version of the *Anomalist* (www.anomalist.com). Jim lives in Duluth, Minnesota and Allen in Albuquerque, New Mexico.
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New Energy Times Archive

# New Energy Companies and Inventors

## Status Reports on Technologies and Claims

*This is a continuing series of updates on the activities and achievements of new energy companies, organizations, and inventors.*

**ENECO**

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ENECO has shifted its focus from cold fusion work to an exciting new solid-state energy conversion process (which of course might eventually prove useful in converting heat from certain cold fusion-related processes). Prof. Peter Hagelstein of MIT, now a consultant to ENECO, and ENECO Chief Scientist Yan Kucherov, made a presentation about this physics and technology at a meeting of the Materials Research Society in Boston in November 2001. The company's press release concerning the new development:

**NEW SEMICONDUCTOR-BASED ENERGY CONVERTER TO IMPROVE EFFICIENCIES OF SOLAR POWER AND REMOTE SITE GENERATORS**

**Invention could replace photovoltaics & thermoelectrics in many systems**

SALT LAKE CITY - November 26, 2001 - ENECO, Inc., a company focused on the development of energy sciences, announced today that it has invented a semiconductor technology that efficiently and affordably converts heat from a wide variety of sources to electrical energy using solid-state thermionics. Scientific papers describing this new technology have been submitted for publication in two leading physics journals.

ENECO believes the new technology, which is based on solid-state thermionics, should find numerous applications in conversion of solar and fossil fuel energy to useful electricity. Systems could be scaled to fit any size residential or commercial application.

When applied as a topping cycle for conversion of concentrated solar power (CSP), the technology is projected to operate near 30% conversion efficiency at 500°C. Total efficiency of such applications would be significantly greater than photovoltaic or basic CSP systems.

When sunlight is not available, solar energy systems can be supplemented with biomass fuels. Heat exchangers supplying energy to ENECO converter modules could accommodate open flame heating from biomass fuels, such as wood, straw, rice husks, etc. found in remote sites.

Existing commercial and residential CSP heat systems could be retrofitted with ENECO technology to yield electricity along with thermal energy. Residual energy could also be saved in a thermal energy storage (TES) system for later conversion.

The company's technology could soon help to solve the problem of long-term power outages in homes across the nation. Currently residential central heating and ventilation will not operate during electrical power outages. An ENECO converter located inside or near the home heating system would be fired from gas, oil, or other residential fuel. The electricity would power furnaces, fans, and associated heating control electronics during power outages.

Generating electricity at remote sites powered solely by fossil fuels is envisioned as an application of ENECO technology. For example, remote sites powered by ENECO technology would use half as much fuel as thermoelectric-based generators for comparable power output. This means refueling half as often, an especially important consideration when providing provisions and services to remote sites.

According to company officials, solid-state thermionics has great appeal because of its low-operating temperature, inherent reliability, and quiet operation, in addition to high-conversion efficiency. The technology works without any moving parts and generates no pollutants. Costs may also prove to be quite attractive. The company suggests that commercial implementations should be less than $1,000 per kilowatt.

Speaking of the new field of solid-state thermionics that emerged in the mid-1990s, ENECO President Lew Brown said, "Our approach is the first to yield high efficiency heat energy conversion." Prof. Peter Hagelstein of MIT and Dr. Yan Kucherov of ENECO have been at the leading edge of new heat conversion research since 1997.

In independent laboratory testing, ENECO devices have yielded absolute conversion efficiencies nearing those of some internal combustion engines and more than twice that of thermoelectrics, the nearest competing technology. The work has been partially funded by DARPA.

About ENECO

ENECO, Inc. is a privately held company with headquarters in Salt Lake City, Utah that specializes in the development of new technologies for energy conversion. ENECO scientists began development of a new kind of semiconductor device in 1997 that enables the efficient conversion of heat to useful electricity. With patent applications filed in the United States and Europe, ENECO anticipates that commercial product development will proceed over the next two years. To date, private investors and research contracts from government and industry have funded ENECO research. With its technology validated by independent testing, ENECO plans to engage strategic industry partners both in the private and public sectors to develop specific applications and begin production and selective licensing of its groundbreaking conversion and refrigeration technology by the end of 2002. ❑❑❑

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Ken Rauen

# Sonofusion

Research, true research, is full of unfulfilled predictions, unanticipated results, and mistakes. A researcher cannot be fully prepared when facing the unknown. A researcher goes where no one has gone before, otherwise it would not be research. We have had our share of those experiences. Unfortunately, this report announces one of those mistakes, coming from unanticipated and unknown operating conditions of our ultrasonic reactor. We must scale back the magnitude of the excess heat reported in our last issue. The 8.5 watts of excess heat reported in Issue No. 40 was incorrect, despite all of the calibrations performed on the system before, during, and after the experiment. Retesting of the same ultrasonic transducers with our new understanding of what is going on still found excess heat, but only as high as 1.5 watts. This was with 10 watts of ultrasonic power input.

The error was found by serendipity. Weeks after the results were written up, I accidentally connected a pair of ultrasonic transducers out of phase. This resulted in excessive voltage in the resonant system of the piezoelectric transducers and their series-connected inductors. The acoustic load on the piezos was reduced, being out of phase, and the "Q" of the resonant circuit rose, thereby increasing the voltage across the piezos. Our custom-made wattmeters which were inserted into the resonant circuit did not like the overvoltage, and some components were "smoked." The Crest oscillator was also damaged. While testing to find the problem, I measured test points with an oscilloscope, which normally were not measured or were not measured frequently.

Another pair of titanium-tipped transducers was tested. Only 1.5 watts of excess heat was found. Operating conditions were changed in an effort to find out what increases or decreases the excess heat. The oscilloscope was kept on the piezo voltages; we were seeing higher voltages than we had ever anticipated. Originally, the wattmeters were scaled to handle 2kV, peak; our hardest-driven signals into Roger Stringham's reactor and original transducers only reached 1.6kVp when we boosted the oscillator to 140 VAC from a variac. Now we were easily seeing over 2kVp even after the out-of-phase condition was corrected. Chris Eddy, the designer of the wattmeters, said that the 2kVp design point was for calibration purposes and that the instrument could take much more before "clipping" occurred. Clipping is an electronic engineer's term for a specific form of distortion. It is the operating point where the electronic signal entering or leaving a transistor or an operational amplifier integrated circuit chip (called an opamp) reaches the component's power supply voltage, and the voltage of the signal above that point gets "clipped off," as if a sine wave drawn on paper were clipped with scissors at the top and bottom of its curves.

Continued probing of the electronics with an oscilloscope during sonofusion runs resulted in the discovery of the wattmeter clipping. One day, my 100x scope probe died in a puff of smoke as I tried to see what a piezo voltage was. The scope registered 3.6kVp before it was fried by the oscillator. At this point, Chris Eddy's reassurance was inappropriate consolation that the system could handle the higher voltages; I was no longer content that the electronics were safe and accurate. My 100x probe was gone. All I had left was a 10x probe, so I went inside a wattmeter to monitor the lower voltages across the sense resistor of the voltage divider network (the solid state components cannot sense several thousand volts directly) and across the current sense resistor. Both points registered voltages way above normal opamp inputs and even their power supply voltages, clearly indicating trouble to me for the first time. Inspecting the signal stages of the wattmeters showed me that the wattmeters were clipping. The DC outputs were not off-scale, so I never suspected that the inputs and intermediate stages could be clipped. We knew the resonant system had a nearly 90-degree phase shift between voltage and current, indicating a predominantly reactive load. We expected large voltages and currents for a tiny power dissipated. We did not anticipate the voltages produced at the wattmeter inputs to ever exceed the overload values.

Testing of many titanium-faced piezo transducers since then has shown us that great variability exists in electrical loading characteristics with the Crest oscillator, far greater than we anticipated. Since the transducer assemblies are of our own design, not even Crest, our contracted manufacturer of the transducer stacks, could know of their performance. We had overdesigned the wattmeters, but it was not enough. So goes research.

We have sought and have seen several runs where "live zeroes" with heavy water were observed. Nominally +0.4 and +0.5 watts of excess heat were observed with heavy water by reducing oscillator supply voltage, changing the frequency sweep window, and changing the argon pressure. Turning off the oscillator produced +0.32 watts of nominal excess, an offset error, showing the live zeroes to be fairly good. We are just now running a deuterium-depleted water sonofusion run with fresh titanium stacks, which has maintained about +0.35 watts of excess, that same offset error seen before. Despite the calibration offset, the system is capable of detecting an energy balance, so we believe that the excess heats measured do exist.

We are not as close to commercializing a sonofusion demonstrator reactor as we had thought. We still think we can do it, though we are not sure if what we have at present will be decisive enough to convince the skeptical and disinterested side of the scientific community that cold fusion is real. We will explore improvements that may increase the excess power. ❑❑❑

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# Upcoming Events

## Energy 2002
## Energy Efficiency Expo

June 2-5, 2002

Palm Springs Convention Center
Palm Springs, California

www.energy2002.ee.doe.gov

## Windpower 2002

**June 2-5, 2002**
Portland, Oregon

Watch www.awea.org for information as it becomes available.

## HTech 2002

International Hydrogen Energy Engineering and Applied Technology Exhibition

May 10-12, 2002
Beijing, China

http://hydrogen.newenergy.org.cn
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The Ninth

## International Conference on Cold Fusion (ICCF9)

**May 19-24, 2002**
Beijing, China

## The Ninth International Conference on Cold Fusion (ICCF9)

*International Convention Center*
*Tsinghua University, Beijing, China*
*May 19-24, 2002*

The study of Cold Fusion (CF) phenomena, sometimes referred to as "New Hydrogen Energy" (NHE) is progressing in numerous laboratories all around the world. More than ten years old, the field is enjoying ever more reproducible experiments and better interactions with the scientific community. A large variety of experimental approaches will be addressed at the Conference, together with theoretical attempts to interpret the observed phenomena.

The important sponsorships that have been secured for ICCF9 (Fundamental Research Division, Ministry of Science and Technology Physics Division II, Natural Science Foundation of China, Chinese Nuclear Physics Society, Department of Physics, Tsinghua University) guarantee that the Conference will maintain the most rigorous scientific standards. As stated in Lerici at ICCF8, the theme of ICCF9 will be coherence: Coherence between Nuclear Physics and Solid State Physics; Coherence between Cold Fusion and Hot Fusion; Coherence between Research and Development. We are glad to see the progress in all three aspects in the past years.

**The following are some topics that will be covered at ICCF9:** heat and related products; nuclear processes and transmutations; materials; innovative approaches; and theories.

**The Conference will consist of oral and poster presentations. The official language of the Conference will be English.**

**Pre-registration, registration, and submission of abstracts should preferably be performed using the Conference website, which will be updated regularly, and will provide all necessary information and interactive procedures. Those who do not have access to the Internet are kindly requested to contact any one of the Conference Secretariats.**

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**Watch the ICCF9 website for updated information as it becomes available.**

http://iccf9.global.tsinghua.edu.cn

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# Lessons from the Enron Collapse

Jed Rothwell

In December 2001, the Enron energy trading company declared Chapter 11, in the biggest bankruptcy filing in U.S. history. The ten largest filings since 1980 include two other energy companies: Texaco in 1987, and Pacific Gas & Electric in 2001.

Last year, Enron was the seventh largest corporation in the U.S. It was considered one of the most aggressive, successful, and politically well-connected. It made close friends with high officials in the U.S., Britain, and India. Rivals and enemies accused Enron of exploiting the confusion in newly deregulated utility markets for electricity, natural gas, water, and fiber optic communications. They say its accounting practices deliberately obscured profit and loss to confuse stockholders and regulators. Many people believe Enron masterminded the California energy crisis, fleecing rate payers and the state for billions of dollars.

Enron's political influence was extraordinary. The CEO is a close personal friend of President George W. Bush, and his biggest campaign contributor. Enron executives huddled with Vice President Cheney to help write the National Energy Policy. In May 2001, in an article titled "Bush Task Force on Energy Worked in Mysterious Ways," the *New York Times* reported: "Richard S. Shapiro, senior vice president of the Enron Corporation, a major Republican contributor and the nation's largest trader of wholesale electricity and natural gas, said top executives from his firm spent half an hour with Mr. Cheney, but he could not tell how much this may have influenced the final report."

The collapse had many causes. Enron made failed investments in fiber-optic networks, a power plant in India, and water distribution in the U.K. Top executives in the company are accused of unethical behavior. The SEC is investigating shady deals in which they allegedly enriched themselves, and formed partnerships designed to hide $500 million in losses. These are serious problems, but corporations have survived worse, and Enron could have been fixed with new management committed to reform. The fatal blow was the collapse in the price of energy and the sudden end of the California energy crisis, which drained cash and ruined Enron's credit. Enron was mainly a trading company, a business that depends on good credit and customer confidence.

What lessons do these events hold for cold fusion and other radically new and cheaper energy sources? Giant corporations are not as powerful as most people think. Stock value, capital, political connections, and clout can be erased by market forces, or by the public, in this case the enraged rate payers of California. If the public ever realizes that cold fusion is real, oil companies and the DOE will be doomed.

The energy industry has vast wealth, power, and influence. The U.S. has fought wars, in part to protect oil company interests in the Middle East. It sends billions of dollars in oil revenue to Saddam Hussein and other tyrants, who are committed to building weapons of mass destruction. None of this is necessary. The *New York Times* estimates that the U.S. could save 1.6 billion barrels of oil per year, more than all imports from the Middle East, with a single innovation: hybrid automobiles, now being sold by Toyota and Honda ("Sunday Magazine," December 9, 2001, "Hybrid Cars"). We risk nuclear annihilation, enrich our worst enemies, and run up gigantic trade deficits supposedly because the public does not want energy efficient automobiles, even though the savings in fuel would pay for the extra cost of the engines. It seems more likely that conservation is unpopular with policy makers. Judging by its actions, the government's main goal is to shore up oil company profits. The energy industry is ruthless. It is willing to risk catastrophic global warming to protect profits. It cuts short countless lives with pollution and flattens mountains to dig coal. If ever a corporation has held sway over national energy supplies and policy, and was in a position to dictate policy for its own benefit, it was Enron. Yet, when circumstances changed, Enron's power evaporated.

The California crisis was the main cause of Enron's demise. In retrospect, it is unlikely there was a significant physical shortage of generator capacity in California. In the first half of 2001, California consumed less electricity than in 1999 or 2000, yet it paid billions of dollars more, and power outages occurred. Investigators suspect that some generator plants were deliberately taken out of service ostensibly for maintenance, but actually as a ploy to tighten supplies and trigger emergency purchases. When the Federal government imposed price caps, and power companies could no longer collect a hundred times more revenue per kilowatt-hour than normal, the incentive to withhold supplies vanished. Maintenance went back to normal and the missing capacity reappeared. Many new generator plants are under construction in California and the Pacific Northwest. It seems likely there will be a capacity glut for the next five or ten years.

Left-wing critics say this fiasco demonstrates the failure of deregulation. They point to the City of Los Angeles, which has a city-owned generation system, and never suffered from a shortage or high rates. Conservative critics say the problem is that the market is half-regulated and half-free. From my perspective, the problem is not the laws, regulation, or deregulation, it is that these companies are trying to sell obsolete, overpriced technology to unwilling customers.

Last spring Vice President Cheney dismissed conservation, saying it "may be a sign of personal virtue, but it is not a sufficient basis for a sound, comprehensive energy policy." California rate payers cut consumption 10% by turning off unnecessary lights, buying new refrigerators, and compact fluorescent lights. They put Enron out of business. If the public—consumers and voters—ever realizes that cold fusion is real, it will insist the research be funded and products brought to market. The energy companies, the DOE, the Patent Office, the administration, OPEC, and many others will fight this, but the public has more power than all of them combined. ❑❑❑

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# Power Paper Unveils
## Revolutionary Ultra Thin, Flexible Battery

TEL AVIV, ISRAEL – Power Paper™ Ltd. of Israel has introduced a patented new battery technology that produces ultra-thin, caseless, low-cost power sources that are almost as flexible as paper. Just 0.5 mm thick and customizable in virtually any shape and size, Power Paper batteries free product designers from the constraints of rigid housings for the first time, making them ideal for disposable microelectronic applications such as single-use medical devices, smart cards, smart tags, and multimedia enhancements for entertainment items, novelties, and electronic packaging.

Customers license the technology, purchase the proprietary materials from Power Paper, and produce their customized power source in-house on standard silkscreen printing presses, permitting easy integration into their production and assembly processes. Power Paper can also provide a customized manufacturing and assembly solution.

### A New Kind of Battery

Power Paper utilizes Zinc and $MnO_2$-based cathode and anode layers fabricated from proprietary ink-like materials that can be printed, pasted, or laminated onto virtually any substrate, including paper. This not only gives the cells their flexibility but also produces a dry battery that eliminates the need for a hermetically sealed metal case. It also removes all conventional limitations on a battery's shape and size.

A one-square-inch Power Paper printed cell will provide a 1.5V with a capacity of over 15mAh and will hold for over a two-year shelf life. Cells can be used in multiple combinations for higher voltages. All the ingredients are non-toxic and safe, permitting disposal without endangering the environment.

Because it uses standard production equipment, requires no clean or dry-room conditions, and eliminates the cost of the case required in traditional battery manufacturing, a Power Paper cell can be produced for approximately 1 cent per square inch. Even small quantities can be produced at low cost with only minimal tooling expense.

The finished Power Paper cell can be integrated with printed circuits and microchips to perform functions such as controlling prescription drug injections, monitoring smart tags, or transmitting RFID label information over long distances, or adding lights or sounds to a puzzle, greeting card, or product box. This permits virtually seamless integration of a power source within a microelectronic device and opens the door to new applications that were never before possible.

### Meeting Market Demand

"The global movement toward smaller, thinner electronic products is fueling a rising demand for flexible, ultra-thin batteries, but until now the only solutions that are thin enough have been inflexible, hazardous and expensive," said Baruch Levanon, CEO of Power Paper Ltd. "By finding a way to eliminate the rigid case, lower the cost and produce an environmentally friendly cell that is no thicker than a Band-Aid, we have redefined the battery and made it possible to tailor a power source to fit almost any size, shape, and form factor requirements without the limitations imposed by conventional battery housings."

Power Paper is currently licensing its technology for non-rechargeable applications. A rechargeable battery is now under development.

### About Power Paper

Power Paper is a privately held company based in Israel. Founded in 1997, it has emerged as the leading source of enabling technology for the new thin, flexible microelectronic marketplace. For more information, call Power Paper at +972-3-9007525 or visit www.powerpaper.com. [Power Paper Ltd., Kibbutz Einat, P.O. Box 12, Israel 49910; Fax: 972-3-9007505; E-mail: info@powerpaper.com] ❑❑❑

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# Energy Innovations: An Overview

Samuel L. Case*

## Disruptive Technologies

One of the more popular business books of the last couple of years has been *The Innovator's Dilemma*. Author Clayton Christensen of the Harvard Business School describes what he calls "disruptive technologies"—technologies and business models that challenge established businesses. For example, digital photography is challenging traditional, film-based photography, online stock trading is disrupting the business of full-service brokers, and hand-held digital appliances are challenging notebook computers.

During the early stages of a disruptive technology, it appears marginal and non-threatening because it serves only a small niche market. The profits from these budding technologies, while enough to nourish a small start-up, are too small to interest large corporations. And, in any case, their customers are not interested because the new technology doesn't meet their needs. Over time, however, as the technology improves, it begins to replace existing models. By the time it matures, it is often too late for established businesses to get on board. Remember IBM scrambling to catch up with Apple's Macintosh computer?

At the start of the twenty-first century, the field of energy holds a number of highly disruptive technologies at various stages of development. Some, like photovoltaic power, have been in development for decades—long enough for several large energy companies to nurture their own solar divisions. Others, like micro-turbines and distributed power generation, have the potential to seriously disrupt the existing utility-based structure of generating and distributing power.

In this paper, we're going to look at how innovations in energy production and distribution are going to dramatically alter the existing landscape. And, because everyone uses energy, these technologies are going to effect not only existing businesses, but everyone else as well. Twenty-five years from now, changes in the production and distribution of power will have altered not just the energy industry, but the lives of everyone on the planet.

## History Repeating

In many ways, the beginning of the twenty-first century recalls the early years of the twentieth century, when a revolution in technology was occurring on several fronts. There was, at that time, a sense that everything was going to change and an appreciation of the infinite possibilities offered by the new technologies of the era. Electricity and telephones were beginning to come into general usage, the automobile, the airplane, and wireless communications were being developed. The general belief was that science and technology were going to usher in an era of health and plenty. And, indeed, people's lives were profoundly changed, even if blind faith in the power of technology was eventually replaced by a more realistic view.

Innovative business people were quick to capitalize on the new opportunities. At the turn of the century, electric power plants were small and distributed throughout cities, with many competing providers. There were several types of automobile—steam, electric, and internal combustion—and many different small companies producing them. Autos and trucks were beginning to diversify land transportation, which then consisted of rail, light rail, and horse vehicles.

There was also a burgeoning interest in solar and wind energy. For example, before the advent of cheap natural gas, there was a flowering of solar water heaters in the late nineteenth century. By the year 1900, in Southern California, there were more than a million rooftop solar water heaters and 300,000 swimming pool heaters. By the 1930s, thousands of farms on the windy Great Plains were powered with small wind turbines. These home light plants began to disappear as the Rural Electrification Administration brought utility power to the Midwest. And the solar heaters were displaced by water heaters powered by cheap natural gas.

As the century continued, the radical, disruptive technologies were either displaced or settled into a sustaining mode. The story of the mid-twentieth century is that of consolidation and gradual improvement of the new technologies. Large utilities and power grids took over the smaller power producers and their cheap power replaced the small, renewable technologies. The triumph of the internal combustion engine turned oil into the primary fuel for transportation.

A century later, there is once again a sense of infinite possibilities, as old technologies get smarter and new technologies open up unexpected vistas. In the energy sector, there is the promise of unlimited, pollution-free power at low cost, as the use of hydrogen as a fuel becomes feasible. Small-scale, distributed power generation is again looking attractive, as are renewables, like wind and solar. An important difference between centuries is that the rose-colored view of the benefits of technology has been tempered by considerations relating to the environment and quality of life. These considerations are now one of the driving forces in energy policy.

In the field of transportation, we are again looking to diversify—but, in this case, to high speed rail and light rail. Once again, there are several different kinds of automotive vehicles—the internal combustion engine is being challenged by electric, hybrid, and fuel cell models. Technological advances and market economies will determine the eventual winners in this contest—and the result will have a profound effect on the energy sector.

Several new technologies and business models have the potential of being highly disruptive to the energy sector. One—efficiency—already demonstrated its disruptive power in the 1980s when lowered demand for power helped to bring about a sharp drop in oil prices. But energy is a unique case because all businesses employ it; the effects of an innovative technology, therefore, may be far reaching. Those businesses that adopt new, more efficient modalities, for example, may achieve an advantage over their competitors.

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## Status Quo

At the start of the new century, the pattern of world fuel consumption remains roughly the same as in the last quarter of the twentieth century. Oil remains king, followed by natural gas and coal, then biomass, hydropower and nuclear. Natural gas consumption surpassed coal for the first time in 1998; indeed, the use of coal has shown a slow decline since 1996. Overall, total worldwide consumption of fossil fuels increased only 0.1% in 1999. In the U.S., power from biomass fuels (which includes methanol) surpassed hydropower in 1999. And, in the developing world, biomass in the form of wood remains a major fuel for cooking and heating. Renewable energy sources, such as wind and solar, while growing at a rapid pace, still account for a very small percentage of consumption.

Utilities with centrally based power plants and extensive distribution systems remain the dominant source of electric power and natural gas. Many of these utilities, however, have lost their status as regulated monopolies as deregulation of the power industry proceeds in many states. These changes have proven to be disruptive to the power industry in several areas, most notably in California, where a botched deregulation led to dramatically increased prices for consumers and bankruptcy for at least one major utility (so far).

Transportation, which is closely linked to energy use, has been largely fueled by petroleum for the last hundred years. While various experimental vehicles are on the roads, virtually all autos, trucks, buses, and trains are still powered by gasoline and diesel fuel.

But, as we discussed in the opening section, this stable picture is illusory. Vast changes are in the works, driven by market forces, environmental concerns, and innovative technologies. After one hundred years of mostly sustaining development, oil companies, coal producers, independent power providers, utilities, and automotive industries are highly vulnerable to new, disruptive technologies. We will discuss these technologies later on, but first, let's look in greater detail at the energy landscape as it appears today. These are the industries that will be most vulnerable to the disruptive energy technologies described later on.

## Petroleum

Petroleum products represent 40% of the total energy consumed in the U.S., with consumption growing at a rate of 0.8% in the 1990s and accelerating. Petroleum products fueled our planes, trains, and motor vehicles for most of the twentieth century, and continue to do so in the twenty-first. Only now are there new fuels in development that may offer alternatives to oil.

Ever since petroleum became a major source of energy, we have heard widely varying predictions on when the supply would run out. Now it appears that all these predictions have been erroneous: we will probably never run out of oil. Computer-based techniques have brought about a revolution in oil exploration to such a degree that industry experts now believe that new technologies will replace petroleum long before the supply gives out.

To add to this argument, a respected physicist, Thomas Gold, theorizes that oil and natural gas are not "fossil fuels," but a product of the earth's deep magma. According to Gold, hydrocarbons predate fossils and are probably being *continuously replenished*. Suffice it to say for our purposes here that, although the theory is obviously controversial (academically disruptive?), Gold marshals compelling evidence and is being taken seriously by geologists.

## Natural Gas (Methane)

So it looks as if we are not going to run out of oil—or natural gas, for that matter. At present rates of usage, the supply of natural gas is projected to hold out for 200 years (or, if Dr. Gold's theory is correct, indefinitely). As in the case of petroleum, new technologies are projected to eventually replace natural gas before the supply runs out. At present, natural gas supplies a little more than 20% of U.S. energy.

Natural gas is becoming the fuel of choice in the U.S. and throughout the world, in part because gas combustion produces much less pollution than either petroleum products or coal (it also creates only one-half as much carbon dioxide as coal). Consumption rose by 1.9% yearly during the 1990s and is accelerating; consumption is growing even faster in Europe and developing economies. Seventy percent of new homes in the U.S. are fueled by gas, and there are a growing number (a thousand, at present) of transit buses running on compressed natural gas. This trend is expected to accelerate, partly because of the promising fuel cell technology: an excellent source of hydrogen for fuel cells, at present, is methane reformed into hydrogen and carbon dioxide.

Recently, there has been renewed interest in a technology first developed in the 1920s that converts methane to liquid fuels like diesel or gasoline (gas-to-liquids). The methane-derived fuels are less polluting than the fuels presently in use—an important factor in places where regulators are coming down on high-polluting diesel fuel. Natural gas is presently converted into liquid form by freezing; the liquefied natural gas (LNG) is then transported in refrigerated tankers and reconverted to a gas for consumers. This is a costly process; a large LNG project can cost as much as $10 billion. Nevertheless, the technology has allowed gas to be transported from previously inaccessible areas.

The gas-to-liquids technology also allows natural gas to be utilized in areas far from the end use, but the cost of large conversion plants is much less than the LNG plants—more on the line of $2.5 billion. Chevron, for example, is building a huge gas-to-liquids project in Nigeria that will produce low-polluting fuels for Europe and other parts of Africa. Projects like these in different parts of the world will enable the utilization of natural gas that was previously burned off as a waste product from oil production.

## Coal

After three centuries as a primary energy source, the use of coal is declining. While still providing 20% of the total energy consumed in the U.S., consumption declined in 1999 to 1987 levels. Consumption of natural gas surpassed coal for the first time in 1998. The environmental damage caused by coal mining has come under fire from environmentalists, and the pollution from burning the fuel has also been cited. Electricity generation is the largest source of pollution in the U.S., and the great majority of that comes from older, coal-fired power plants. While coal will remain an important fuel for a few more decades, natural gas has become the fuel of choice for newer power plants.

## Nuclear

Nuclear power is also moving towards a decline. During the 1990s, total global capacity rose only 4.7%, in contrast to a total growth of 140% in the 1980s. Nuclear power is expected to peak in 2002, and then start to decline. No new reac-

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tors are under construction in Europe and North America and only a few in the rest of the world, while aging reactors are being taken off line. The Department of Energy estimates that 31% of total nuclear capacity in the U.S. will be permanently shut down by 2015. Germany aims to phase out all of its nuclear plants over the next twenty years.

The inability of nuclear to compete in a level marketplace is coming to light: nuclear has long been subsidized by national governments. This inability, combined with perceived environmental dangers and difficulty in disposing of radioactive waste, have made utilities unwilling to invest in any new, costly undertakings. At present, nuclear accounts for roughly 5% of total energy consumption in the U.S., all of it used to generate electricity.

The recent energy crisis in California, coupled with high prices in the oil and natural gas markets, has emboldened the nuclear forces to push their technology once again. The nuclear industry in the U.S. is pointing out that nuclear plants do not produce greenhouse gases or contribute to trade deficits from foreign oil. A company in South Africa is marketing mini nuclear plants which they claim are safer and more cost-effective than the present technologies. The disposal of radioactive waste, however, is still not being addressed.

### Hydropower

Although hydropower is a renewable, non-polluting source of energy, some of the giant dams that produce it have come under fire as harmful to the environment. That, plus the fact that the best sites for productive dams have already been employed, means that hydropower will not be a growing source of energy. Some environmental groups have even advocated the destruction of some smaller dams so that the rivers can return to their natural state. Hydropower supplies about 8% of total power consumed in the U.S.

### Utilities and Independent Power Producers (IPPs)

Deregulation has hastened an already marked trend that is separating power production from distribution. Utilities are increasingly becoming distributors of gas and electricity, dependent on the IPPs and the energy markets for the products they bring to consumers. The energy crisis in California has pointed out the downsides of this trend as an ill-planned deregulation allowed the IPPs to charge whatever the market would bear, while limiting the amount utilities could pass on to consumers. Two unhappy outcomes of this ongoing debacle have been the bankruptcy of the largest California utility, PG&E, and sharply increased gas and electricity prices to consumers.

### Electrical Mythology

There is a pernicious myth in circulation that 13% of all electricity used in the U.S. is related to computers and the Internet. The myth continues that this figure will grow to 50% in the next decade. The present figure is actually 3% and is not likely to increase much, because even as electronic devices proliferate, they also grow more efficient.

The faulty figures have been traced to lobbyists for the coal industry. Electricity usage is actually growing at about 2% a year, hardly enough to justify a crash program to build a number of expensive new (coal-fired) power plants.

This illustrates the fact that government policy decisions must be seen as a highly disruptive force in the energy industry. When deregulation brings higher prices, as it has in California, it can eventually lead to even greater disruption for the industry. As prices rise and the threat of blackouts increases, this gives much greater impetus to alternatives like micropower and renewable sources. In California, especially, there has been an upsurge of interest in renewables and distributed power. "If the days of cheap, dependable power are gone," the thinking goes, "then I had better produce it myself for my home or business."

Although the utilities are in the news right now, every industry associated with energy is likely to suffer severe disruptions during the coming few decades. This includes all industries involved in the exploration, extraction, transportation, refining, and distribution of fossil fuels and other natural resources.

Not only industries will be affected, but also the countries that depend on sales of petroleum to support their national economies. Countries like Mexico, Venezuela, Norway, Russia, Nigeria, and many Middle Eastern states would be severely impacted by a shift away from oil and the resulting lowering of usage and drop in price.

The entire energy sector will be adversely affected unless the various industries begin to take measures to deal with the sources of these disruptions. These sources will be the subject of our next section.

### Disruptive Technologies

There are presently a number of technologies that could prove disruptive to the energy sector. Each one taken separately poses much less of a threat than their combined strength. There is *synergy* at work here—the combination of innovative models is going to bring about greater change than a simple total of all. The trend to distributed power, for instance, is going to get a big boost as fuel cell technology improves—and as the price of renewables comes down. Together, these three innovative models could create a new landscape that would prove highly disruptive both to energy producers and distributors. We will describe what such a model might look like later on, but first we need to look at how each innovation manifests itself.

### Distributed Micropower

In March of 2001, the Los Angeles Department of Power and Water ordered 141 microturbine power systems from Capstone Turbine Corporation. The units will be situated in different locations throughout the city, but will have a combined power output of four megawatts. This purchase by the municipally owned utility illustrates a strong trend toward small, distributed power systems.

In 1985, the average size of a new generating unit was 200 megawatts, with some units putting out as much as 1,400 megawatts. By 1998, the average size had declined to 21 megawatts. These are still utility-sized units; many industries and commercial establishments have been ordering single units from Capstone and other manufacturers that generate just 5 to 30 kilowatts.

The kind of open competition and price drops that government policy makers envisioned has not panned out in many deregulation efforts. Instead, the vital, open markets fueled by new business models, technical innovations, small

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company start-ups, and price competition appear to be happening in the field of small-scale power generation. Efficient, low-emission microturbines, renewable sources like wind and solar, and promising fuel cell technology are all contributing to the trend towards small-scale power, both independent and grid-connected. Many different models are presenting themselves as businesses and homeowners consider the new possibilities.

This trend reprises the situation at the turn of the twentieth century. Thomas Edison envisioned a distributed system, with many small power plants and businesses generating their own electricity. And, indeed, by 1907, small, individual systems accounted for 59% of electricity generated in the U.S. Many of these plants employed waste heat in an early version of cogeneration.

The advent of alternating current and transformers, however, which made it possible to transmit current over long distances, and the highly efficient steam turbine began to favor the economies of scale of larger generating plants. By the 1930s, large, monopolistic, utility systems had been established in most industrialized countries. The central power plants connected to an electrical grid steadily reduced the cost of power and provided reliable service. Industries involved in the generation and distribution of power continued to expand in an orderly manner with improvements in sustaining technology.

By the 1980s, however, the industry reached limits in efficiency gains from size, and flaws in the system began to become apparent. The high exposure of the system to fluctuations in fossil fuel prices became apparent. Increased environmental awareness exposed the ecological disruption necessary to support the large-scale generation of electricity. Fossil fuel extraction and uranium mining, polluting combustion, enormous dams for hydropower, and high voltage transmission lines were perceived as disruptive and harmful to the environment. At the same time, small-scale power technology began to surpass the grid system in efficiency and environmental friendliness.

The new microturbines, especially when fueled by natural gas, emit roughly half as many harmful gases and particulates as do the existing central generating stations. The reduced pollution stems partly from higher efficiencies — and the efficiencies are improved by employing the heat from exhaust gases for space heating—or cooling, with absorption coolers. This dual use sends efficiency ratings into the 85% to 90% range, compared to 35% to 70% at central power stations. In addition, there are no power losses from transmission lines over long distances.

To summarize, there are several forces driving the trend toward distributed micropower systems:

- ❑ Increased costs of power resulting from fuel price increases and fallout from deregulation policies.
- ❑ Increased reliability and efficiency of small systems, coupled with lower costs.
- ❑ Perceived drawbacks in large-scale generating systems, including unreliability, high cost of maintenance, and environmental considerations.
- ❑ Environmental benefits of small-scale systems, including the use of renewables.

The systems that are emerging as a result of these forces will greatly benefit energy consumers, but will certainly prove disruptive to the power producers and distributors and all related industries. Their increased efficiencies will also impact the primary energy suppliers, like the oil companies. Coal will decline even faster as natural gas replaces it in electricity production and the large central generating stations are phased out.

Micropower has many characteristics of disrupting technologies. The field has a growing number of small, fast-moving companies, like Capstone, that are creating and riding the trend towards distributed power. And, because many analysts don't perceive this trend, they still evaluate micropower using conventional criteria and make conservative market projections.

The movement towards distributed micropower will grow as fuel cell technology is perfected. Fuel cells are even more efficient and environmentally friendly than the microturbines. Already, a few fuel cells are beginning to find their way into businesses and industrial applications. We will discuss this promising technology at greater length below.

## Renewables

This section on renewable sources of energy covers those newer technologies that are likely to show disruptive tendencies. Hydropower is a renewable source, but it is unlikely to grow appreciably over the coming decades. The same is true of geothermal power, which generates small amounts of power in certain areas of the world, but is unlikely to show much growth. There are a number of experimental technologies that attract small amounts of investment, such as tidal power, wave power, power from temperature differentials in the ocean, and small hydropower installations. While each of these may prove useful in certain areas, none of them seem to hold the potential of becoming disruptive to the energy industry as a whole.

### *Solar*

There is a point in the life of disruptive technologies when their cost becomes attractive and their utility surpasses that of existing models. This is often a sudden shift, after a long period of marginal use and non-competitiveness in most areas. Photovoltaics—producing electricity from the sun—is fast approaching that shifting point.

Photovoltaics has followed a classic disruptive path, albeit a longer one than most new technologies. First invented in 1957 at Bell Laboratories, solar cells quickly found special use in the space program to power satellites and, later, manned space flights. As the high price gradually came down, the technology was employed for various remote power applications like road signs, navigational buoys, and small calculators. In the 1970s, photovoltaic modules began to appear on rooftops, particularly on houses where connecting to utility lines was prohibitively expensive. In conjunction with battery storage, homeowners could generate their own power apart from utilities.

Because utility power was still cheap and reliable, however, the high cost of the systems made them unattractive to most. Utilities experimented with a few photovoltaic installations and related technologies, including solar-powered vapor engines to generate electricity, but high costs and cheap fossil fuel dampened their enthusiasm. The profit curves didn't look attractive to the large utilities and most of their customers were not demanding solar power.

Several factors are now contributing to a new outlook for photovoltaics. First, the technology is a natural for distributed power systems. The fuel, after all, is distributed for free, and

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rooftops are a prime location for the modules. Second, after a few years of stagnation, the price is moving down once more. It is now at $3,500 per kilowatt; a further drop to $2,000 per kilowatt would make it competitive with fossil fuel. Research on different kinds of photovoltaic cells has increased, and industry experts expect this drop in price to happen within the next ten years (economies of scale will also contribute to lower prices).

Photovoltaics have found new uses all over the world, particularly in developing countries where thousands of villages are not connected to any power grid. Thin film solar technology allows the devices to be incorporated into building materials like roofing shingles, siding, and even windows, thus further reducing the installed cost. Production of photovoltaic modules is growing at an average rate of 30% a year and this pace is expected to continue. The 30% growth rate would mean that solar capacity would reach over 200,000 megawatts by 2020. This projection will probably change sharply to the upside, however, when the price of solar becomes competitive with fossil fuels.

Most analysts envision solar panels being connected to the existing power grid. This could change, however, if cheap, reliable storage devices—"load-levelers"—come onto the market. The existing technology consists of expensive, relatively short-lived battery systems. With a better way of leveling energy production during nights and cloudy days, many homeowners and businesses might opt for complete disconnection from the grid. Better batteries or high tech flywheels may accomplish this, but the fuel cell, described later on, appears to be the best candidate for leveling energy loads from intermittent sources like solar and wind.

The slow development and downward price curve of photovoltaic cells over forty-five years has given businesses plenty of time to consider their options and prepare for the solar revolution. Unlike many disruptive technologies that are developed over periods of just a few years, photovoltaics has given the energy industry decades to get ready. Oil companies like Amoco, Shell, and BP are now investing in the technology. Oil producing countries are likewise aware: Sheik Yamani, oil minister of Saudi Arabia, speaks of the need to prepare for renewables. And Dubai, an oil-producing state of the United Arab Emirates, has proposed employing a new technology to produce hydrogen from sea water in conjunction with the German automaker, BMW.

As we discussed above, utilities have flirted with solar, and the flirtation will certainly become more serious as the price drops. Utilities will be able to move into the market of retailing and installing rooftop collectors and charging for use of their power grid (in this scenario, the electricity generated by the rooftop panels would all feed into the grid). The technology would become disruptive both to utilities and power producers, however, if a significant number of customers opt to leave the grid and produce and store their own power. We will present such a scenario later on.

### *Wind*

Wind power is growing even faster than solar at present. Wind turbines are being installed all over the world, particularly in Northern Europe, where strong, onshore winds are put to good use (there are also large turbines being constructed offshore). Wind power reached a total installed capacity of over 16,000 megawatts in 2000, and the capacity installed each year is increasing by 65% to 70%. If the present growth rates are sustained, wind power could supply 10% of the world's electricity by 2020.

According to the U.S. Department of Energy, electricity from wind turbines is now competitive with gas and coal-fired plants and, as the turbines increase in size, the price will continue to drop. Although there is also a small market for home or ranch-sized wind machines, the bulk of investment is going into large turbines for utilities and IPPs.

As far as being disruptive to established industries, the success of wind power may encourage disinvestment in more expensive nuclear technology. Germany, for example, has opted to phase out its nuclear plants and develop offshore wind power. Right now, however, it appears that by itself the technology is not a major threat to the energy industry: utilities can incorporate it into their business models and IPPs are building their own wind generators. In the long run, wind may displace fossil fuels to some degree, but it is likely to play a disruptive role to primary energy producers only in conjunction with other renewable technologies.

Although wind power generally gets favorable reviews from environmentalists because of its renewable, non-polluting characteristics, there are criticisms. The turbines are noisy, dangerous to birds, require large tracts of land, and are unsightly in scenic areas. Proponents of solar point out that photovoltaic panels on rooftops have none of these drawbacks. Proponents of wind power argue that the cost of electricity from wind turbines is already competitive and will likely fall in comparison to fossil fuels, as these rise in price.

### *Biomass*

Biomass is a poor cousin to solar and wind in terms of publicity, but surpasses both of them in total power. Producing electrical power and useful heat from the combustion of agricultural crops, agricultural waste, sewage sludge, and organic industrial waste is a fast-growing technology. Another biomass product—methanol—is mixed with gasoline. Some analysts project that the growth of biomass worldwide could surpass that of both wind and solar over the next twenty years, particularly in the developing world. In China, for example, many villages employ simple composting digestors of animal waste to produce methane gas, which then fuels small electric generators.

Although there are a number of high-polluting waste incinerators, burning organic material no longer needs to be a smoke-producing operation. New technologies gasify the waste and burn the resulting methane as cleanly as natural gas. A further environmental benefit of this renewable fuel is that it is carbon dioxide neutral in terms of emissions (the growing plants absorb carbon dioxide, then give it up when burned).

In terms of disruption, energy from biomass is similar to wind in that it can be incorporated into the business structures of utilities and power producers. Any disruption to the fossil fuel industries will come only in combination with other renewables—and then, only over a number of decades.

## Hydrogen and Fuel Cells

### *The Hydrogen Economy*

There has been a lot of talk about the "Hydrogen Economy," but what exactly does that mean? At present, we have an economy based mostly on fossil fuels. Could hydrogen replace them? The answer is a qualified "yes." Hydrogen can power our homes and businesses, run all our vehicles, ships, and, possibly, aircraft. It can be burned to provide heat and used for cooking, just like natural gas and propane. It has the

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advantages of being the most ubiquitous and plentiful element in the universe and of being completely non-polluting. The only by-products of its combustion are heat and water. The qualifications stem from the fact that the present sources of hydrogen are mostly fossil fuels.

Hydrogen can be extracted from natural gas, gasoline, or methanol, and this process is cleaner and more efficient than burning those fuels in internal combustion engines. Hydrogen can also be reformed from natural gas at the well head; carbon dioxide is a by-product of this process, but can be re-injected into the gas field to provide continuing pressure (which helps bring more gas to the surface). The hydrogen can then be transported by pipeline or turned into a liquid, like natural gas.

In addition, hydrogen can be split from the oxygen in water ($H_2O$) through the process of electrolysis. This involves a simple process of applying an electric current to water and collecting the released gases. When the electricity for this reaction comes from renewable sources, like wind or solar, the entire process is even more ecologically friendly than extraction of hydrogen from fossil fuels.

In terms of safety, hydrogen is very similar to natural gas in its combustibility. This is a technology we are used to dealing with in our stoves and furnaces. Although the storage of hydrogen for fuel cells in vehicles is still being worked on, using it in buildings presents few new challenges or dangers.

### *Fuel Cells*

If you can imagine a battery that, instead of being recharged, can be refueled, you have a basic understanding of fuel cells. Fuel cells recombine hydrogen and oxygen into water, creating heat and an electric voltage in the process. This electricity can be used to power a building, or run a vehicle. Fuel cells are already running a small number of buses, trucks, and autos, as well as powering a few buildings. While the technology is still in the experimental stage, it is garnering large amounts of investment for many different models. Research has been focused on reducing the size and weight of the cells used for vehicles and on developing a better storage system for hydrogen.

Fuel cells promise all the advantages of electric vehicles—zero pollution, quiet operation, low maintenance, and reliability—with none of the disadvantages—short range, low power, few accessories, and costly battery replacement every few years. In addition, the cells run at roughly three times the efficiency of an internal combustion engine.

Fuel cells also promise reliable, non-polluting power for individual buildings. As the technology is perfected over the next decade, it will boost the already strong trend towards distributed power. The First National Bank of Omaha, mindful that a one-hour power outage can cost it $6 million in loss of transactional ability, has invested in a fuel cell-based power system. The cells supply 800 kilowatts to the mainframe of the data center and operate in the "high nines" in reliability (99.9999% availability).

Projections vary as to the speed with which fuel cells will come into general use, but there is general agreement that the technology has arrived and is presently being perfected. Analysts estimate a U.S. market of $10 billion by 2010, representing 10,000 megawatts.

## Efficiency

The energy crisis of the 1970s led to an increased supply of fossil fuels as government encouragement and high prices led to expanded exploration and production. The crisis, however, also prompted significant gains in the efficient use of energy by the private sector. As a result of this increased efficiency, between 1979 and 1986, U.S. GDP rose 20% while total energy use *fell by 5.5%*. This pattern confounded most energy analysts and led to a supply glut which, in 1986, crashed energy prices, particularly in the oil industry. Small and large producers were adversely affected by this crash. Unfortunately, the lowered energy prices also discouraged users from instituting more energy-saving programs.

Growth in efficiency waned for ten years, then reappeared in 1996. Since 1996, energy savings in the U.S. have averaged 3.2% per year, more than in the 1980s. This trend has been given a big boost, recently, by increased energy prices on the world markets, and deregulatory efforts that have brought higher prices to end-users. At the same time, however, the present administration has promised increased production, creating the possibility of a reprise of the energy crash of 1986 in a few years.

Efficiency can be a powerful force, especially in a time of high prices when small savings translate into large monetary gains. Amory Lovins, of the Rocky Mountain Institute, was

### Compact Fluorescent Lighting (CFLs)

Here is a brief illustration of the potential of efficient technology.

Lighting consumes 20% of electricity in the U.S. Business and industry have already adopted fluorescent lighting, which is significantly more efficient than the common incandescent bulbs used in most households. Incandescent lighting is a nineteenth century technology: 90% of the power goes to produce heat. Compact fluorescent lighting (CFL) can replace most incandescent bulbs, producing the same amount of light with a third to a quarter the amount of wattage. A CFL equivalent of a 100 watt bulb, for instance, uses only 27 watts.

The technology for compact fluorescent bulbs has progressed and the price has come down. A 100 watt CFL equivalent bulb now costs about $12.00, versus $0.75 for an incandescent. The CFL bulb, however, will last ten times longer than the incandescent, and, during its life, save about $50.00 in energy costs. If three-quarters of incandescent bulbs were replaced with CFLs, it would be possible to halve the power used for home lighting. In California, this would mean savings of 3% in the total amount of electricity used throughout the state—the equivalent of several large power plants.

***Benefits of CFLs:***

- Savings on consumers' utility bills—approximately 15%
- Possible lower electricity prices because of decreased demand
- Fewer new power plants
- Decrease in pollution and greenhouse gases

Efficient technologies like this can result in energy savings at a fraction of the cost of building new generating facilities.

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among the first to emphasize that increased efficiency is, in effect, a cheap energy "source" (Lovins calls this source "negawatts"). Regardless of whether energy is saved or produced, the result is more available energy. Potential savings from efficiency is a vast resource; some estimates place it at half the country's present energy usage. More efficient vehicles, buildings, industrial electric motors, lighting, and appliances can add up to tremendous energy savings at a fraction of the cost of increasing supply (Lovins estimates one-sixth the cost).

Certain new technologies are already contributing to the efficiency revolution, like the 85% to 90% efficient micropower installations, and hybrid vehicles which effectively double the gas mileage of conventional vehicles. New, fuel-saving gas turbines from Capstone and others are finding their way into hybrid buses and autos, and super-efficient fuel cells will raise efficiency even more.

A for-profit spin-off from the Rocky Mountain Institute is researching what it calls a "Hypercar™," an ultralight vehicle whose innovations will raise the level of efficient fuel use to a new standard. When powered by fuel cells, ratings of 200 miles per gallon of fuel and up are forecast for the Hypercars, while power, amenities, and safety will remain the same or better than present vehicles. Hypercar, Inc. will license its technology to automotive suppliers and automakers.

An unforeseen benefit of creating efficient and user-friendly buildings—both new and retrofitted—is a jump in employee productivity. Such qualities as good lighting, temperature control, and air quality have translated into productivity gains of 1% to 15%, far outstripping any savings in energy. These kind of productivity gains can give a distinct competitive advantage to a business—and constitute a disruptive force to competitors.

Highly efficient buildings can also encourage the use of renewable technologies by making their installation more affordable. Super-insulated buildings, for example, require very little heating or cooling; a photovoltaic system, therefore, could be sized to provide power mostly for lighting and appliances. And if these are also designed to use less energy, the cost of the solar system can be further reduced.

Efficiency has already proved itself to be a powerful disrupter to the entire energy industry. Utilities got behind this trend in the 1980s when they realized that lowering demand cost less than building expensive new power plants. The decoupling of production from distribution has, unfortunately, thrown a wrench into this encouragement of conservation and efficiency (another unforeseen downside to shortsighted attempts at deregulation). Utilities and IPPs now are more likely to see their profits coming only from increased sales.

### Unexpected Benefits

An upgrade in the lighting system in a drafting facility at Pennsylvania Power and Light resulted in energy savings of 69%. Even more significant, however, was the 13% increase in productivity and the 25% drop in absenteeism.

Designing energy efficiency and better use of daylight into a Lockheed Engineering facility saved $500,000 a year in energy bills—and brought about a 15% gain in productivity, coupled with a 15% drop in absenteeism.

Source: Rocky Mountain Institute

The increased cost of gas and electricity to end-users, however, will certainly prompt defensive action by homeowners and businesses. Higher prices will have the salutary effect of bringing about increased efficiencies throughout the economy—and this will prove disruptive to the industries still unaware of the power of efficient technologies.

## A Disruptive Scenario

Earlier, we mentioned that it would be the synergy of new technologies being employed together that would be most likely to bring disruption to the energy sector. The scenario below will be brought about by several of the new models working together. Here is how a renewable and hydrogen-based economy might appear in the microcosm of your home in the year 2025.

The photovoltaic cells built into the roofing material of your home generate electricity that powers the home during daylight hours. In addition, some of the power is used to separate hydrogen from water by electrolysis. The hydrogen runs a fuel cell that provides power for the house at night and on cloudy days. Enough hydrogen is stored (in a tank outside the house) to power the house for two weeks of cloudy weather; in a pinch, you can have a tank delivered to your door in the same manner that propane is delivered today. The stored hydrogen also provides fuel for your car—which uses very little, being a Hypercar. And the gas is piped to your stove, furnace, and water heater.

The photovoltaic system is affordable, both because installed costs have come down and because the house employs the latest in efficient technology. As such, it needs very little heat or air conditioning, and the lighting and appliances use one-third the power of today's houses. *Thus, efficiency is added to renewable energy, fuel cells, and the trend towards distributed power to produce a home that is effectively energy independent.*

This synergistic model can be repeated, with variations, in business establishments. One scenario has the fuel cells in automobile fleets providing power for buildings or feeding current into the utility grid when the cars are parked. Whatever the variations, however, it's easy to see that a scenario using only photovoltaic panels with advanced load levelers like fuel cells would, by eliminating the need for any other fuel or distribution system, be highly disruptive to the entire energy sector. Energy independence might bring lower costs and greater reliability to individual users, but it would bring revolutionary changes to the energy industry.

## Futuristic Technologies: A Wild Card

In March of 1989, two chemists at the University of Utah, Pons and Fleischmann, announced that they had produced atomic fusion reactions in a simple tabletop device—so-called "cold fusion." Other researchers, however, were unable to duplicate their experiments and the cold fusion experiments were debunked and the whole affair regarded with some derision by many established scientists. As a result, researchers were unable to obtain funds to pursue the anomalies, and research into cold fusion went underground.

In spite of being underfunded and poorly regarded, however, during the past ten years, researchers all over the world have duplicated and improved on the original Pons-Fleischmann experiments. These include physicists at such highly regarded institutions as Stanford Research International, the Naval Air

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Warfare Center at China Lake California, Shell Research in France, and Osaka University in Japan.

The reason for the continued interest in cold fusion is that it promises a very cheap, simple form of non-polluting energy, unlike nuclear fission—or "hot fusion," which has been researched at tremendous expense for the last fifty years, but produced few promising results. Research into the viability of the simpler cold fusion technology, however, has been colored by the politics of academia, with billions of dollars of funding at stake.

Cold fusion is only the tip of the iceberg in the field of new energy research. There are experiments involving magnets, electrostatics, low-energy nuclear reactions, pulsed laser beams, and radiant energy, all of which have shown varying degrees of promise. Some researchers have claimed to have achieved so-called "over unity" results, meaning that more energy is released from a reaction or device than is put into it, creating a kind of free energy. Detractors argue that this is all pseudo-science and goes against known physical laws. Proponents counter that they are not breaking any laws, but rather accessing nuclear, chemical, or other kinds of energy that are locked up in molecules or atoms, just as nuclear reactions release the bound-up energy of the atom.

Some researchers argue that they are tapping into the energy of the vacuum, a concept that conventional scientists find difficult to swallow. That there is energy contained in the vacuum of space is accepted by modern physics, but most mainstream researchers dispute the possibility that individual inventors or small research labs could marshal the technology to tap into it.

But isn't all this new energy research simply more of the traditional search for a perpetual motion machine—the province of crackpot inventors and mad scientists? Wouldn't mainstream science accept sound research if it existed? The answer to the last question is muddled in the politics of science and academia. A careful, unbiased, reading of existing research, however, reveals a number of well credentialed and believable researchers who have achieved some very impressive results.

One company, BlackLight Power, Inc. has garnered $25 million in investments, as well as interest from two major utilities and some established investment firms. The head of the company—Randell Mills—claims to have collapsed the electron orbit of hydrogen, creating large amounts of energy in the process, as well as useful, new compounds from the smaller hydrogen atoms, or "hydrinos." This is the company that is probably closest to producing commercial products among the new energy technologies.

There is often the problem of disbelief in dealing with disruptive technologies. Managers at large companies may have difficulty believing that a disruptive technology in its early stages could ever pose a challenge to their well-established business models. But in the case of the technologies discussed here, an added barrier to entry may be the inability to believe that these technologies are, or will ever be, scientifically credible. If managers listen only to conventional scientists, they will leave the field to the small companies developing these subversive modalities. If, however, they take the time for a closer look, they will see that there is intriguing, hard evidence from reputable research labs.

A closer look will also reveal that these inventions are following the classic path of disruptive technologies. They are being developed mostly by small, underfunded companies and labs, they have been dismissed by established science and ignored by most of the business community. In addition, while their performance is not yet commercially viable, they are slowly showing improvement and gaining credibility (and investment dollars). Further, the capacity for disruption by these inventions is spectacular—much greater than most new technologies—and when one or more of them does become commercially viable, it will be much too late for others to get on board.

## Conclusion

While it may be difficult to get a clear reading on exactly which direction the energy revolution will take, it is a foregone conclusion that there will be major changes over the next twenty-five years. The entire energy sector will be affected by several new technologies—most likely by all of them acting in a synergistic fashion. If progress continues at the present rate, by the year 2025 the production and delivery of energy will be cheaper, more reliable, and more widely distributed. In addition, pollution and carbon dioxide emissions will be significantly reduced.

The industries that will survive this revolution will be those that can read the writing on the wall and prepare innovative business models to cope with the disruptive forces. Regardless of the form the energy revolution takes, there will still be models that will generate significant profits for those businesses savvy enough to create them.

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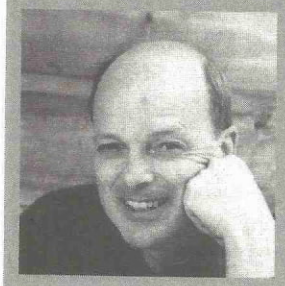
### About the Author



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# The Electric Air Arc is an MHD Generator

Neal Graneau,* Peter Graneau,** and George Hathaway***

*Reprinted with permission from the American Society of Mechanical Engineers. This paper first appeared in the Proceedings of the 36th Intersociety Energy Conversion Engineering Conference (July 29-August 2, 2001).*

*Infinite Energy* has earlier profiled the work of Peter and Neal Graneau with water arc explosions (See *IE* No. 10, p. 39 and *IE* No. 13/14, p. 92), which yield apparent excess energy. In "Why Does Lightning Explode and Generate MHD Power?" (*IE* No. 25, p. 9), Peter Graneau suggested that chemical bond energy is released in lightning explosions via an "MHD" (Magneto Hydro-Dynamic) principle. Now we are privileged to be able to publish the following paper in which the Graneaus and George Hathaway report significant excess energy from *laboratory* air-arc explosions—akin to natural lightning. Following the paper are comments on this air-arc work from several scientific observers, as well as a "comment on the comments" by the authors. I am in hearty agreement with their remark, "What we all struggle with is the technology which finally decides between winners and losers." —*Eugene Mallove*

**Abstract**

MHD power generation in air arcs is a new discovery and area of active interest. As these arcs are always known to explode, charged ions must be driven radially outward and travel across the lines of encircling magnetic flux. This motion induces axial e.m.f.'s which augment the arc current. When the increased current flows through a resistor, it is found to produce more heat than the energy that was supplied by the capacitors to initially create the arc. It is argued that ions are propelled by the release of the stored potential energy of repulsion between the atomic nuclei in molecular $N_2$ and $O_2$. Electricity generation from the energy stored in the atmosphere is of great interest because air is freely available anywhere on earth.

## Introduction

Despite a century of research on lightning and exploding air arcs, it has only recently been discovered that pulsed air arcs generate MHD (magneto-hydrodynamic) electric power in a manner similar to commercial MHD generators. However, one major difference between the two technologies is that commercial units rely on a separate magnet while an exploding arc utilizes the encircling magnetic field of the arc current itself without requiring any external magnet. This was first discovered at Oxford University in 1999.[1]

The forces which drive the ions across the magnetic field lines of a modern commercial generator are of thermal origin. For example, the ions may be propelled by the flame jet of an oil burner. However, in 1989 it was found by one of the authors (PG) that pulsed air arcs of short duration (<1 ms) are not hot and the expansion that is always observed by the presence of a shockwave is not the result of thermal forces.[2] It is therefore probable that the arc ions are accelerated by the release of stored potential energy during the dissociation of $N_2$ and $O_2$ molecules. The fact that arcs produce large quantities of nitrous oxides ($NO_x$) and ozone ($O_3$) demonstrates that many bonds must be broken during the arc. The energy was first stored in the nitrogen and oxygen molecules when the atoms became bonded upon collision with each other. As the particles were brought to rest relative to each other, their kinetic energy was partly converted into stored potential energy. This energy of repulsion between the atomic nuclei is referred to as the bond energy. It is not to be confused with the thermal dissociation energy which is the quantity of thermal energy that needs to be supplied in order to break the bond. The kinetic energy of the pre-collision nitrogen and oxygen atoms, some of which is converted into the stored potential energy, is derived ultimately from incident solar radiation.

## Experimental Proof of Energy Generation

Experimental proof of MHD electric energy generation in air arcs was obtained with the simple discharge circuit of Figure 1. This relied on a capacitor bank of $0.64<C<3.75$ μF charged to a voltage, $V_0$ in the 10-30 kV range. The initially stored energy supplied by the capacitor bank was

$$E_S = \text{stored capacitor energy} = \tfrac{1}{2} C V_0^2 \text{ (J)} \quad . \qquad (1)$$

The capacitor voltage was applied across a load resistor, $R_L$, in series with a triggered air spark gap of 4.5 mm length between domed electrodes with tungsten arcing inserts. The trigger energy was less than one Joule while the capacitor

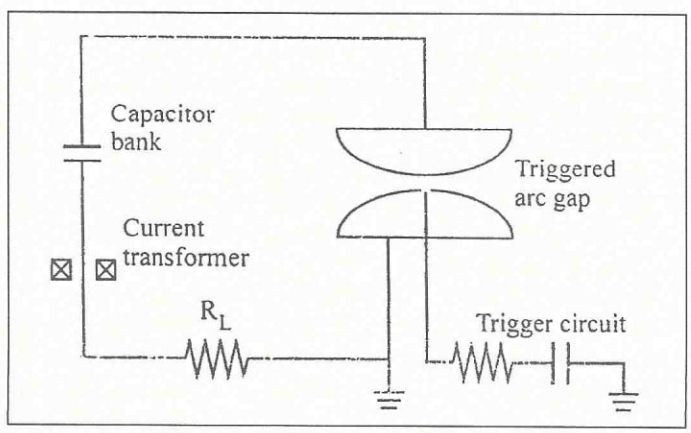


**Figure 1.** Air arc discharge circuit with load resistor, $R_L$.



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bank could store up to 1.69 kJ. The load resistor was a stack of 15 cm diameter, 2.5 cm thick, carbon ceramic disks capable of withstanding large current pulses up to 80 kA peak current. The resistance of the stack used in the experiments described here came to $R_L$=2.38 Ω.

The instantaneous discharge current, $i$, was measured with a current transformer and recorded on a digital oscilloscope. The signal was then processed on a computer to yield the action integral ($\int i^2\,dt$) where $t$ represents time. The electrical energy converted to Joule heat in the load resistor is

$$E_L = \text{Joule heat in } R_L = R_L \int i^2\,dt \quad \text{(J)} \quad . \qquad (2)$$

For appropriate values of $V_0$, $C$, and $R_L$, it was found that

$$R_L \int i^2\,dt > \tfrac{1}{2} C V_0^2 \quad \Rightarrow \quad E_L / E_S > 1 \quad . \qquad (3)$$

In fifty shots of input energies $30<E_S<500$ (J), the Joule heat dissipated in the load resistance, $E_L$, was found to be greater than the energy supplied from the capacitor bank, $E_S$. The results for the measured ($E_L/E_S$) ratio are plotted in Figure 2 as a function of the supplied energy, $E_S$. The scatter of the points is primarily due to the statistical nature of the breakdown process which causes the electron emission site location and efficiency to vary from shot to shot.

It must also be appreciated that the capacitors supplied the energy losses in the rest of the discharge circuit as well, including the electromagnetic and acoustic energy radiated into the environment. The major components of the circuit losses were (a) the ionization energy which is then stored in the arc plasma and later returns as heat, (b) the losses in the capacitor itself, and (c) all ohmic losses in the conductors of the circuit and in the plasma. Hence we know that the total MHD energy generated by the arc explosion was greater than indicated in Figure 2.

## The Cause of Loud Air Arc Explosions

To fully appreciate the implications of the inequality in Equation 3, confirmed by the results shown in Figure 2, the cause of the arc explosion has to be determined. It has been demonstrated that electrodynamic forces are incapable of causing the explosion of the arc with the magnitude and direction of the measured forces.[2,3] Until 1972, it had been assumed that thunder and the loud explosion of laboratory air arcs were caused by a thermal shockwave. Then Viemeister[4] published his findings with regard to hot and cold lightning which he summarized as follows:

> Cold lightning is a lightning flash whose main return stroke is of intense current but of short duration. Hot lightning involves lesser currents but of longer duration. Hot lightning is apt to start fires while cold lightning generally has mechanical or explosive effects.

This was confirmed by direct measurements of the force and current dependence of confined arc explosions.[2] Further, a pulsed arc does not cause steam when striking a pool of water, and while it will tear paper placed across its path, it will not ignite it.

Faced with the fact that neither electrodynamic nor thermodynamic forces are responsible for the arc explosions, it became clear that a second and independent source of energy, in addition to the capacitor energy, was involved in the phenomenon. Since chemical changes occur in the gaseous arc medium, we have been forced to examine whether stored chemical energy can cause a rapid expansion of the arc column before the ionic motions become collision dominated and are slowed down. In order to produce the known arc byproducts, the diatomic bonds in $N_2$ and $O_2$ molecules must first be broken. This leads to the possibility that the explosion energy is in fact the liberation of stored diatomic bond energy.

## MHD E.M.F. Generation Mechanism

Without pursuing the details of the chemical energy conversion processes, there can be no doubt, on account of the loud explosion, that in our experiments nitrogen and oxygen ions in varying states of ionization are driven radially outward from the arc column with a velocity $v_r$ in the direction indicated in Figure 3.

In crossing the encircling lines of magnetic flux, these ions generate an axial electric field strength, $E_m$, in the direction of current flow given by

$$E_m = v_r \times B \quad , \qquad (4)$$

where $\boldsymbol{B}$ is the magnetic flux density. Integrating the $E_m$ field along the arc gap leads to the motionally induced e.m.f., $e_m$ between the electrodes in the $z$ direction,

$$e_m = \int v_r\, B\, dz \quad . \qquad (5)$$

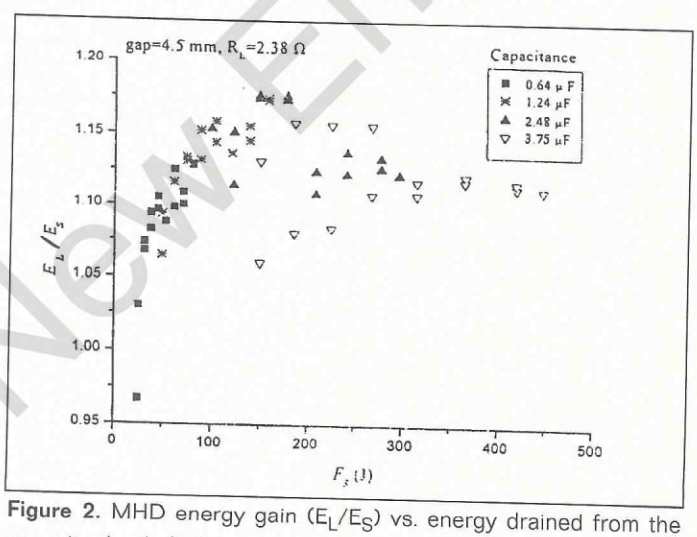


**Figure 2.** MHD energy gain ($E_L/E_S$) vs. energy drained from the capacitor bank, ($E_S$).

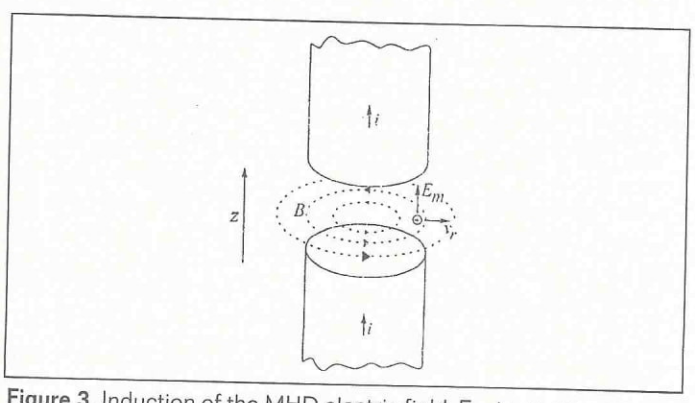


**Figure 3.** Induction of the MHD electric field, $E_m$, in an arc gap.

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This represents the e.m.f. which should drive current in the direction of the discharge current, *i*. It may be described as a forward e.m.f. resulting from the conversion of mechanical (kinetic) energy into electrical energy. Conversely, back e.m.f.'s are produced by the conversion of electrical to mechanical energy as in a motor. The explosive nature of pulsed air arcs is well documented in the arc physics literature.[5-7] Allen and Craggs[6] found radial expansion velocities of the optical arc channel in atmospheric air up to $2.5 \times 10^3$ m/s.

Unfortunately, it is not possible to accurately calculate the MHD energy generated by the pulsed arc current. It would require unavailable knowledge regarding the number of ions involved and their charge state as well as their velocity distribution. The current distribution is also unknown and it determines the strength and variation of the encircling magnetic flux density, ***B***. Faced with these unknown quantities, the only means of determining the magnitude of the MHD effect is to measure it by experiment.

### Chemical Energy Liberation

To satisfy the inequality in Equation (3), two requirements must be met. First of all, in addition to the capacitor energy, another stream of energy must flow into the discharge circuit. Secondly, the additional energy must be converted to electrical energy so that it can be absorbed in the load resistor. These two requirements are satisfied by the proposed MHD generator principle. No other mechanism has been found or suggested.

The additional energy source must be in the form of ion kinetic energy in order to achieve MHD generator action. As suggested in the Introduction, this second stream of energy is assumed to be liberated chemical bond energy derived from the dissociation of $N_2$ and $O_2$ molecules.

The treatment of bond energy in the chemistry literature is confusing. Many authors treat the bond energy as the amount of thermal energy required to break the bond, ignoring the energy that is stored in the bond itself. However, the bond is also discussed as a balance of attractive and repulsive forces acting like a compressed spring. In the same way that a spring and its compressing mechanism store potential energy, so must a chemical bond. This is the energy that can be liberated to produce high ion kinetic energy.

The diatomic or covalent bond is caused by a strong force of attraction between the two atoms. This attraction is sometimes described as a Van der Waals force and may be due to spin coupling of the two valence electrons in common orbitals. Whatever the precise microscopic mechanism of atomic attraction, it has to be counteracted by an equal Coulomb repulsion between the two nuclei in order to prevent fusion. The repulsion becomes greater as the nuclear distance shrinks, and as a result the stored potential energy in an $N_2$ molecule is particularly large because of the strong attraction between two atoms with three unpaired electrons each. This is why nitrogen is very stable and therefore abundant in the atmosphere and also a large source of stored energy.

The only way of liberating this potential energy is to, somehow, remove the electronic attraction. The thermal bond dissociation process relies for this purpose on the collision of two molecules with sufficient mutual kinetic energy. The quoted dissociation energy for $N_2$ molecules is 225.5 kcal/mole. The pulsed arc plasma is quite cool and as a result thermal dissociation is not expected to occur to any great extent. More importantly, the final outcome of the explosion is to heat the surroundings. If heat were also the cause of the explosion, then by the principle of conservation of energy embedded in the first law of thermodynamics, we could not expect that this process could lead to a gain in energy. As a consequence, thermal dissociation cannot be the cause of the second energy source.

The mechanism of the attractive force in a covalent bond relies on the highly complex electromagnetic interactions between electrons with magnetic spin components. It is possible that these interactions are severely affected by the high current density of the arc, leading to a reduction or even elimination of the attractive force in the chemical bond while the electrostatic repulsion force between the atomic nuclei remains unaffected. It is quite likely that this electromagnetic decoupling may require less energy than thermal collision dissociation, pointing to the possibility of an energy gain.

If the arc is fired in a closed vessel containing pure nitrogen gas, then the individual atoms created during the explosion will eventually recombine back into $N_2$ when the two atoms collide. As a consequence of the principle of chemical irreversibility as contained in the second law of thermodynamics, this recombination can only occur at the expense of heat drawn from the surroundings. The energy that is drawn from the surroundings plus some of the existing kinetic energy of the free atoms is then stored in the newly formed covalent bonds ready to be exploited by a later arc. This demonstrates that such a device would ultimately be running on atmospheric heat which is caused by solar heating. The MHD generator and load produce heat which compensates for the energy drawn out of the environment and thus the device could produce electrical output without a net warming or cooling of the atmosphere.

While it may seem surprising that we are proposing an energy generator that runs on atmospheric heat, we can draw a comparison with hydroelectric power which also uses atmospheric heat to evaporate low altitude water and return it to the top of the mountain in order to use it to drive the turbine. To continue the analogy, $N_2$ is like the water at the top of the mountain and atomic nitrogen acts as the water after it has passed through the generator. The MHD generator behaves like the turbine and extracts energy while the working substance changes state.

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# SCIENTIFIC COMMENTARIES on the Graneau *et al.* Electric Air Arc Paper

## Dr. Brian Ahern

It is my understanding that it is customary to lose up to 50% of the energy in the switch itself. Furthermore, the capacitor does not typically discharge all of its energy in the first cycle. I believe that this energy delivery is also only about 50%.

Both of these facts about discharge suggest that your results are much greater in their "over-unity content." I think it is important for the reader to understand these shortcomings in energy delivery, so that they may better understand the physics of the energy release.

The measurement of the heat dissipated in the load resistance is not discussed. People will want to know how and where these load reactances were accounted for.

Finally, there appears to be a peak at 150 joules for this configuration, or at least an asymptotic limit. To what do you attribute the source of this limitation?

## Professor John O'M. Bockris

In respect to the source of energy in the experiments on arcing, I would like to draw attention to some work I reported in 1994 (R. Sundaresan and J. O'M. Bockris, *Fusion Technology*, 26, 261, 1994). In these experiments, passage of ~10 amps between two pieces of *spectroscopically pure* carbon in water caused an arc to form. Small amounts of iron were formed. The amount was roughly proportional to the current passed.

Thus, nuclear energy may become available in some arcing situations.

## Dr. Clarence L. Dulaney

(1) For MHD generation you must have a net gain of output over input. It appears to me that you have not made a complete energy balance, since you have not included how much energy it takes to charge your capacitor. The $1/2CV^2$ formula for stored capacitor energy applies only to the "steady state" conditions. It is the amount of energy you can obtain from a capacitor under "reversible" conditions, and may vary widely by how the capacitor is discharged. Also, the amount of energy required to charge a capacitor from zero varies with the rate of charge, etc.

(2) I wonder if you should not use the "reactance" of the circuit rather than $R_L$ as your energy multiplier because of the high frequency exponential variation of the current. Also, what is the resistance of your carbon-ceramic resistor at high frequency?

(3) On page 3, you note the effect of "ions" on generation of an axial electric field. This makes good sense in explaining Figure 2. However, later you speak of breaking the diatomic molecules into "atoms." Which do you believe happens?

(4) I think that you have your thermodynamics backward. It requires 225.5 kcal/mole to break the bond in nitrogen. When the atoms (or ions) recombine, the same 225.5 kcal/mole is recovered as some sort of energy (light, sound, or heat) in the case of your arc. The light and sound must come from something.

(5) There is nothing confusing in the chemistry literature about chemical bonds. It requires the bond energy to break bonds, and the bond energy is recovered when the atoms recombine.

(6) The van der Waals force has nothing to do with chemical bonds. It is a very small physical attraction of atoms or molecules near their critical temperatures.

## Robert Gray

(1) The first paragraph of the Introduction ends with "This was first discovered at Oxford University in 1999." I had to read the paragraph over and over again to figure out exactly what is being claimed to have been discovered in 1999, and I am still not sure. Is it that air sparks can be modeled by using MHD theories? Or that there is a net energy out greater than the energy stored in the capacitor? Perhaps it is my lack of experience with commercial MHD generators that leaves me unsure what the claim of first discovery is at this point in the paper.

(2) I am surprised that you do not mention or reference any other claims by other "inventors" of "more energy out than in" when a device uses a spark gap. I understand that these inventors are not necessarily scientists and such claims are typical of the "free energy" crowd, but such claims of over-unity when using spark gaps have been around for a long time.

(3) As well as claims of underwater arc welding resulting in more energy out than in. (I seem to recall an article in *Infinite Energy* Magazine some years ago on this.) Still, perhaps, a little too much in the "fringe" science arena for inclusion in the paper. The point is that the claim that there is more energy in (air or water) sparks is not new. What is new is your analysis and explanation and experimentation.

(4) I am also surprised that the work of Ken Shoulders and his "Charged Clusters" is not mentioned. This, I would think, is another example of air spark gap action exhibiting MHD effects (quasi-stable charged tori or micro lightning balls. Note: Ken also claims that the effects are cold. The charged clusters do not melt the material they enter, yet they leave holes and other traces.)

(5) In connection to Ken Shoulders' Charge Clusters, I would like to mention Clint Seward and Dr. Chiping Chen. Seward has patents on "Electron Spiral Toroid" (U.S. Patent Number 5,773,919, and others) which reads, in part: "A containing force can be created by external electromagnetic fields, ions within the vacuum, *or by interaction between the orbiting electrons themselves*." (I added the emphasis.) If I read this correctly, the claim is that electrons themselves can organize into stable spiral toroids. The mathematical proof of this, I am told by Mr. Seward, is being prepared for publication by Dr. Chiping Chen of the MIT PFSC, a plasma research lab. Dr. Chen has sent to me a preprint of a paper, but I have not studied it yet to see if the claim of a self-stable electron spiral toroid, with no additional field, is true. (Maybe I am just misinterpreting what is being claimed.) I think this may be related to what Ken Shoulders is observing in air spark gaps. I have some references on my website at www.rwgrayprojects.com/energy/torus/torus01.html.

(6) Another phenomenon I recently read about, occurring under the "right" conditions in diatomic molecules, is the observation of a proton transferring from one atom's

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nucleus into the other atom's nucleus. That is $N_2$ becoming CO. Whether this is enhanced tunneling (nuclear Josephson junction effect?) or some kind of "cold fusion" or other mechanism, I do not know. Since this is observed in biological systems (!) I do not think it is the effect you are seeing. But since you are investigating $N_2$, I thought I would just mention it.

## Hal Fox

When lightning strikes a metal surface (where some of the details of the lightning sparks can be observed) one can see that there are small pits that we strongly believe are caused by charge clusters.

I would suggest that part of the reactions observed in your strong electric discharges also produce charge clusters and that these charge clusters can pick up and carry positive ions which can also provide extra energy by tapping some of the energy from the ZPE or space energy.

Your discoveries of an MHD effect using the magnetic field set up by the arc is, in my judgment, a major discovery. Likewise, the concept that the arc is not high temperature is an important discovery. We find that it is difficult to even define the temperature of an arc created by charge-cluster development. However, as Shoulders provided in his paper presented at the conference in Bethesda, the charge clusters have the capability of vaporizing silicon carbide. It would be difficult to define the temperature of such an arc.

## John H.B. Irving

The basic idea is fascinating. Observing the exact sequence of magnetic and chemical events seems to be the crucial process in the advancement of understanding. My lateral thought on this, unencumbered by any professional scholarship in the subject, came up with the question whether the light generated by the arcs might express against time the details of what chemical paths N and O might be following.

During the last twenty years my own world of analogue and digital sounds and pictures has advanced so strongly that I can imagine how developments in the astronomical observation of the constituent atoms of distant bodies might be advancing equally fast. Perhaps you can now create an apparatus to log spectral changes in light generated in laboratory experiments over continuing periods of micro-seconds.

This, of course, may have happened already without my knowledge.

## Dr. Eugene Mallove

I am reasonably sure that you have done good work and that, indeed, you have what looks like an unexpected "over-unity" energy condition. It is with your explanation of the source of this energy that I take issue. Please understand: I cannot prove precisely what the source of that excess energy is, nor can you. However, I do believe that it is far less likely that it is kinetically-loaded bond energy of any kind that is being liberated here, than that the aether physics being explored by the Correas may be involved. If you examine their website (www.aetherometry.com) and download some of their excellent experimental and theoretical monographs, you will see that in principle there exists an energetic aether which is capable of producing both thermal and electroscopic anomalies.

Furthermore—and I would not expect you to believe this if you had not seen it or measured it yourself—they have aether motors running in self-sustaining mode! (Read my "letter of support" on their website and also that of Uri Soudak, former Chief Technology Officer of Israel Aircraft Industries). This must be the same aether energy, tapped in a different way, that appears in their better-known and patented PAGD™ technology. I do hope you will consider the possible avenues of theoretical explanation that are being offered by what the Correas are reporting. I think it highly likely that their physics could explain the anomalous energy in your air arcs.

## Dr. Thomas E. Phipps, Jr.

I am a layman in this area and so will offer a few layman's comments, amounting to nothing more than guesswork. I take it the bulk of arc current in the plasma is electronic. Then we have high-speed electrons that may have enough energy to either deplete (by impact) the K-shell surrounding one of the N or O nuclei, or, more likely, simply disturb the surplus of electronic charge that exists between two nuclei of a stable diatomic molecule. This perturbation, causing momentary disruption of the electron cloud that is doing the job of holding the molecules together, would be essentially instantaneous from the standpoint of the nuclei, which are very sluggish compared to the electrons. Now, you will say, that the great mobility of the electrons will cause one of them from the K-shell or the next shell to move into the depleted zone before the positively charged nuclei can respond. But that may not be true. There is quantum stability associated with shell structure; consequently there may be some delay, a sort of inertia of "quantum" origin, in correcting the molecular charge imbalance produced by the impact of the are current. Perhaps enough delay that the nuclei can respond to the internuclear charge depletion by beginning to acquire some momentum. In that case the molecule will tear itself apart, there may be ionization of the atomic remnants, and the result may be just as the Graneaus have described. Can quantum mechanics support such a model? In principle the time-dependent Schrödinger equation should handle all such affairs. Dirac assured us that it sewed up all of chemistry. But I have never seen demonstrated its ability to treat a truly dynamic situation of a complex molecular system. Belief in the capability is largely a matter of professional faith.

So there is an opportunity to think that arc-current electrons might trigger with a small amount of energy the release of much larger amounts. The nuclear plus charges in diatomic molecules are happy in relatively close mutual proximity because of a delicate balance of mobile screening charge interposed between them. This is a metastable condition, in that just a small disturbance of that balance could cause the nuclei to realize they are not at all where they want to be. If that disturbance lasts long enough, Humpty-Dumpty will fall off the wall, and release a lot of energy by his fall. I personally find such pictures and arguments particularly persuasive in accounting for thunder. It would be expected in that case that gas pressure would be an important parameter controlling the probabilities of variously branching outcomes of the process. . .and, sure enough, it does seem that the physical character of lightning has recently been observed to change drastically with altitude. Monte Carlo calculations might confirm this.

I trust the experiment has been or will be repeated with controls, such as use of a monatomic gas to show no explosion and no over-unity, the use of diatomic gases of different molec-

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ular weights and at different pressures to see if there are trends of energy release, etc. Finally let me dream about enhancing the effect. Suppose by some trick of aero- or hydro-dynamics the diatomic molecules in the vicinity of a vertical arc could all be caused to rotate (spin) in a horizontal plane. Then the nuclei in the arc, when released by screening charge depletion, would all fly off in the horizontal, transverse to the arc's magnetic field. This would maximize the current induced in the circuit and greatly improve the over-unity performance. Similarly, it would seem that imposing an external magnetic field parallel to the are should enhance performance, perhaps enough to pay the extra electric bill.

Finally, it is amusing to speculate that the cooling effect of systematic extraction of heat from the atmosphere by human efforts, in extrapolation of the Graneaus' plan, might counteract the alleged effects of global warming attributed to the same human efforts. To raise the issue is in any case an interesting exercise in mob psychology, in that the response of environmentalists to such a suggestion will test whether their concern about global warming is sincerely aimed at seeking a technical solution, or whether their main objective is the socio-political one of controlling and dominating their fellow creatures by imposing on them guilt and self-denial.

# THE AUTHORS' RESPONSE
## to Commentaries

We would like to thank all contributors for reading our paper and commenting on it. This is most helpful for the furtherance of our research into a new source of clean energy for the generation of electricity which produces no global warming.

Before responding to the comments, we would like to summarize a certain measure of unspoken agreement. Everyone seems to believe that we have discovered a new way of generating MHD energy. The process relies on a second source of energy besides the energy stored in the capacitor bank. The majority of contributors do not dispute that this is stored chemical bond energy in the diatomic molecules of air. But mention has also been made of nuclear energy and a new form of ether energy.

Ahern is quite correct in claiming that the total generated MHD energy is probably much greater than $E_L$-$E_S$. The MHD augmented current also flows through the arc, the capacitors, and the metallic circuit connections. In these components it must cause further Joule heating in addition to that being developed in the load resistance. Hazarding a guess, we consider it possible that the MHD energy could be as large as 50% of the capacitor energy. No firm explanation can be offered why the data of Figure 2 shows a maximum at 150 J. The downturn in the $E_L/E_S$ curve could be the result of energy donor molecules ($N_2$ and $O_2$) being blown out of the arc column by the stronger explosions.

Length limitations imposed on the paper did not permit us to describe the measurements which gave rise to Figure 2 and which Ahern and Dulaney would have liked to see in the paper. We simply measured $R_L$, at full current and at the high frequency of the current oscillations, as given by the voltage across the resistor divided by the current through it. The voltage determination was carried out with an electronic voltprobe connected to an oscilloscope. A standard toroidal current transformer displayed the oscillating current on the CRO screen. Both signals were fed into a computer for data processing. In accordance with standard electric circuit theory, the resistance was then multiplied by the action integral ($\int i^2 dt$) of the current pulse to give $E_L$ for Figure 2. This is equal to the Joule heat generated in the load resistance. No calorimeters were employed, It means we have taken it for granted that the Joule heat dissipated in the load resistance is $R_L \int i^2 dt$, where $i$ is the instantaneous discharge current.

With regard to the comment by Bockris, we consider it possible that nuclear forces of fission, fusion, and transmutation are present in air arcs. Nobody has previously claimed, however, that they are responsible for the explosion of high current arcs and this is the reason why they were not mentioned in the paper.

As Dulaney explains, what chemists call bond energy is not the energy stored in bonds of diatomic molecules at the time the bonds are formed. Take the $N_2$ molecule. A strong force of attraction between two nitrogen atoms moves the two nuclei close together against the Coulomb repulsion, which prevents nuclear fusion. As in a compressed spring, this process stores potential energy. In order not to confuse it with what chemists call bond energy, we should every time refer to it as potential energy of nuclear repulsion. When the magnetism of the arc interferes with the strong electronic (covalent) binding force, the interatomic attraction is apparently switched off and the stored repulsion forces can then blow the N atoms apart, which are then presumably ionized by the intense high current electron flow. This explosion leads to the eventual emission of light and sound.

With regard to other questions asked by Dulaney, we agree that the Van der Waals force makes little contribution to diatomic bonding. The circuit reactance is not an indication of the heat dissipated in the load resistance. The radial explosion of the plasma, as shown in Figure 3, is compatible with inducing the axial MHD-emf $E_m$. In the field model of Figure 3, the encircling magnetic field is due to axial electron flow and not ion motion. Dulaney's claim that our thermodynamics is "backward" is based on the notion that the only way to break a bond is by thermal energy. We are hypothesizing a nonthermal bond breaking mechanism which allows us to release the stored repulsion energy in a more efficient manner. Unfortunately, such a mechanism was not built into twentieth century thermo-chemistry. Finally, the capacitors are charged with low dc current and the charging loss can be made arbitrarily small. The energy remaining in the capacitor after an arc discharge never amounts to more than a few joules.

What did Neal discover in Oxford in 1999 asks Gray? It should be stressed that conventional MHD power generators convert the kinetic energy of a bodily moving plasma through a magnetic field to electric current energy. The explosion of the arc demonstrates plasma motion in the magnetic field of the arc current. MHD energy must inevitably be generated by this process, but it could be negligibly small. Then Neal discovered by computer (finite element) analysis, relying on Neumann's law of induction, that the MHD energy was not small. He followed this up with his 1999 experiments with the load resist-

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ance and thereby proved that the effect was large.

Gray is quite correct that a number of arc experiments have been published in the last one hundred years which suggest that some energy of unknown origin was liberated. An example is the "singing arc" mentioned by J.J. and G.P. Thomson in their book *Conduction of Electricity through Gases* (Dover, New York, 1969, p. 585). As Gray points out, the energetics of water and air arcs have been a puzzle for all of the twentieth century. The riddle persisted so long because investigators ignored the dominant feature of arcs, which is their explosive nature.

We are not familiar with the phenomenon of proton transfer from one nucleus to another. This subject mentioned by Gray is clearly related to Bockris' suggestion of the involvement of nuclear transmutation.

Charge clusters are cited by both Gray and Fox. Every time we explode an arc in air, we find quite small footprints of the arc column on the electrode surfaces. Under the microscope the arc marks create the impression that small droplets of molten metal have been accelerated across the arc gap and then impacted on the opposite electrode. The acceleration by either electromagnetic or electrostatic forces virtually proves that the droplets carried excess charge. If the charged droplets are the charge clusters to which Gray and Fox refer, then there is room for further discussion of the arc explosion mechanism.

The arc temperature is a difficult concept to define, as Fox points out. Our experiments do not confirm some of the excessively high temperatures claimed in the arc literature. As we pointed out in the paper, pieces of newsprint were punched through and torn by 20 - 50 kA arc current but were not ignited.

When Irving raises questions about the light emitted by air arcs and lightning, we have to confess that we paid little attention to this subject and also ignored the energy carried away by light. The optical phenomena accompanying air arcs are bedeviled by the fact that radiation from the arc column excites air molecules in the vicinity of the arc which in turn emit secondary light making the arc plasma appear to be much more voluminous than indicated by the arc marks on the electrodes. The secondary light is mostly in the ultra-violet band and makes arc photography extremely difficult. Nevertheless, Earth-based spectroscopic studies of electrical discharges in the upper Venusian atmosphere have already been used to confirm the gaseous composition discovered by space probes.

We hope Mallove will forgive us for being reluctant to explore yet another ether. The 2500 year history of physics is full of such constructs of the human mind and all faltered in the face of objective laboratory experiments and astronomical observations. The most famous examples are Aristotle's crystal spheres, Descartes' ether whirlpools, and Maxwell's elastomechanical ether. Many others did not make the headlines.

We can well believe that the Correas have motors spinning which they can justify with a new ether theory. We sincerely hope they are successful in bringing them to commercial fruition. As the editor of a widely read new energy magazine surely knows, our field has not been short of theories. What we all struggle with is the technology which finally decides between winners and losers. We certainly look forward to competing with the Correas, no matter if it is ether or bond energy which drives our machines. Competition is what makes the wheels go round and *Infinite Energy* is doing a splendid job in airing so many competing approaches.

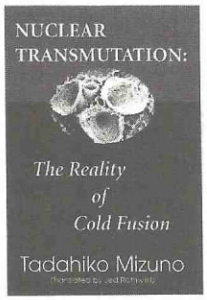
Finally we come to Phipps' thoughtful contribution. Some layman he is who drops us right into the deep end of quantum mechanics. Fortunately he found a way, from fundamental beginnings, to convince himself that a small amount of electromagnetic trigger energy may liberate a much larger amount of stored bond energy.

Control experiments have been on our mind but we are still searching for one. The major difficulty is that monatomic gases have lower breakdown strength than air. Pure $N_2$ gas above atmospheric pressure has higher breakdown strength than air. Hence, if we wish to form an arc at the same voltage and with the same current, we have to change the arc length. This is known to affect the MHD energy generated. Another problem with anything but free air is that a dielectric enclosure has to be provided which, unless very large, will interfere with the ion dynamics controlling MHD action.

We take the pragmatic view that, for whatever reason, air arc explosions do occur and they immediately generate electrical energy. Unfortunately, in the load resistance the electricity converts itself to low grade heat of little utility. The challenge we are addressing is how to transform the MHD electric current energy into something which can be pumped directly into the existing electricity distribution system. This turns out to be far more difficult than it was to find the energy in the first place. We would be grateful for any help we can get from the new energy community.

In connection with this, Phipps' suggestion of applying an axial magnetic field to the arc, and its rationale, is most intriguing. We are thinking about it. ❑❑❑


**SALE . . . SALE . . . SALE . . .**

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# ECLECTIC OBSERVER

Compiled by Eugene Mallove

## MacArthur on War and Character

Following the tumultuous events that have come in the wake of the September 11, 2001 atrocities, worth pondering are some thoughts by a military leader of the past, American Army General Douglas MacArthur. This passage, forwarded to me by colleague Dick Hazelett of Vermont, was part of MacArthur's speech to a joint meeting of Congress, April 19, 1951 (obtained from the *New York Times*, April 20, 1951, p. 4 and also the *Congressional Record* 97, pp. 4123-4125, at p. 4125.):

Douglas MacArthur, 1945

> Military alliances, balances of power, leagues of nations, all in turn failed, leaving the only path to be by way of the crucible of war. The utter destructiveness of war now blocks out this alternative. We have had our last chance. If we will not devise some greater and more equitable system, our Armageddon will be at our door. The problem basically is theological and involves a spiritual recrudescence, an improvement of human character that will synchronize with our almost matchless advances in science, art, literature and all material and cultural developments of the past two thousand years. It must be of the spirit if we are to save the flesh.

Whether one's views are theistic, pantheistic, atheistic, or otherwise, the meaning of "spiritual recrudescence, an improvement of human character" is clear in its general sense (though I wish General MacArthur had not anointed *only* the past two millennia of human accomplishments!). It also seems likely that the character flaws in humanity at large that lead to interminable military conflict are part of a related pathology that compels dominant scientific groups and media in their reckless assaults on beneficial discoveries, such as cold fusion and aether energy. We are assaulted by suicidal terrorists with bombs and anthrax, and by terrorists of the mind who wield poisoned pens and computers.

## New from Akronos

In October 2001, we received the following e-mail announcement from Akronos Publishing:

> Akronos Publishing is pleased to announce that the much awaited text, "Introduction to Experimental Aetherometry Vols. 1 & 2" by P. and A. Correa, is now available on its website: http://www.aetherometry.com.
>
> This text forms a comprehensive overview, both scientific and philosophical, to the monographs in Experimental Aetherometry which have been published on the Akronos website during the last two months. It comprises the following sections, each of which forms a separate HTML document:
>
> 1. The basic problems in Reich's theory of the ORAC anomalies, and the trajectory of the aetherometric solutions.
> 2. Overview of Experimental Aetherometry Vol. 1.
> 3. Overview of Experimental Aetherometry Vol. 2,
> 4. The Specter of Wilhelm Reich.
> 5. Why speak of an Aether?
> 6. On "wishful thinking" at the merger of BioPhysics and Philosophy.

It should be noted that in addition to this *free* material, the Correas have now released further downloadable monographs, up to and including AS2-12, as of this writing.

## Hypocrisy-Squared

MIT Professor Mildred Dresselhaus, formerly head of the Office of Basic Energy Sciences at the U.S. Department of Energy, is at it again. I have taken her to task editorially for an abdication of professional responsibility in the matter of cold fusion (see *IE* No. 36, p. 42). She was on the 1989 DOE panel, whose rush-to-bad judgment set in motion continued abuse of honest science, but there is good reason to believe that Dresselhaus well knows the problems with the 1989 DOE report. In *Nature* magazine of November 15, 2001 (Vol. 414, 332-337 ), she and I.L. Thomas (of DOE) in a special section titled "Materials for Clean Energy," offer an overview of "Alternative Energy Technologies." This is followed by five technical reviews by other authors.

The Dresselhaus-Thomas introduction leads with: "Fossil fuels currently supply most of the world's energy needs, and however unacceptable their long-term consequences, the supplies are likely to remain adequate for the next few generations. Scientists and policy makers must make use of this period of grace to assess alternative sources of energy and determine what is scientifically possible, environmentally acceptable and technologically promising." Needless to say, cold fusion is not mentioned. The half-page assessment of fission and (*hot*) fusion energy ends with this bureaucratic gibberish, "Again, much needs to be done to demonstrate the feasibility of fusion technology and to make it competitive with other options." Translation: "Spend more money for hot fusion."

## Big Banging It

The announcement of a colloquium by Dr. Michael Turner of the University of Chicago, on October 11, 2001 at the Harvard-Smithsonian Center for Astrophysics (Cambridge, Massachusetts):

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*Making Sense of the New Cosmology*

Abstract: Cosmology is in its most exciting period of discovery yet. Over the past five years we have determined the basic features of the universe—spatially flat; accelerating; composed of 1/3rd a new form of matter, 2/3rds a new form of energy, with some ordinary matter and neutrinos; and apparently born from a burst of rapid expansion during which quantum noise was stretched to astrophysical size seeding cosmic structure. Now we have to make sense of all this; What is the dark matter particle? What is the nature of the dark energy? Why this mixture? How did the matter-antimatter asymmetry arise? What is the underlying cause of inflation (if it occurred)? If we succeed in making sense of our universe, this will truly be remembered as a Golden age.

It's good to learn that the Big Bangers *think* they have such a firm grasp of an outline of cosmology. That will make their ultimate fall the more cosmically comical—a Golden Egg-on-Face rather than a Golden Age.

## "Liquid Space"?

*New Scientist* (November 3, 2001, No. 2315) has a colorful, ethereal cover with these challenging words: "Deep in space lurks a ghostly substance that connects you with everything else in the universe. . .Why Einstein was wrong about the ether."

"Einstein wrong about the ether"? Could it be that this mainstream publication out of Britain was venturing into deep heresy in physics? Hardly. The cover story article titled "Liquid Space," by physicist Paul Davies, reviews the evolution of prevailing concepts such as virtual particles and space-time. Davies asserts, ". . .by the early part of the twentieth century, the idea [of the ether] has been discredited and seemed to have been gone for good. Now, however, quantum physics is casting new light on this murky subject. Some of the new ideas that fell from favor are creeping back into modern thought, giving rise to the notion of a quantum ether." Davies titillates with this hollow prospect: "Ingenious new experiments may even allow us to detect that quantum ether in the lab, or harness it for technological purposes." Bah! Davies offers no evidence that mainstream has any such technological devices on the horizon, near or far. But if he would just check the recent coverage in *Infinite Energy* of new ether physics (I prefer the spelling *aether*) and emerging technologies, his mind might be opened just enough to begin to discern the error of his ways.

## The "Small" 1970s Mistake with a Huge 9/11/01 Consequence

The sickening images of both the World Trade Center towers collapsing have been seared in our minds. Word has spread through the general media that the collapse was caused, in the case of both towers, *not* by the immediate impact with the massive aircraft (which the superbly designed structures survived), but by the weakening of the steel beams that were exposed to high temperatures from the prolonged fire fed by thousands of gallons of jet fuel. Less well known is that the choice of the heat- and fire-resistant coating material for the beams may have doomed the buildings and many of the people who were unable to escape during the short period before the collapse.

The September 2001 issue of the monthly newsletter *Access to Energy* (Box 1250, Cave Junction, OR 97523) has an article on this topic. It seems that the first sixty-four floors of each WTC tower had beam coated with the tried and true fire-heat retardant, asbestos. Environmental regulations in the early 1970s led to beams above those floors being coated with an apparently less effective material. Expert Herbert Levine was quoted in the 1970s: ". . .if a fire breaks out above the 64th floor, that building will fall down." His prediction came true. What should have been at least a four-hour period of steel beam endurance, in which many more people could have escaped and the fires perhaps suppressed, shrank to 1-hour and 40-minutes for Tower One and to 56-minutes for Tower Two.

*Access to Energy* editorialized: "The demonization of asbestos, a very useful and safe substance, has been written about many times in *Access to Energy*. . .Asbestos was an early victim of junk science and enviro fear propaganda. These enviros were joined by opportunistic lawyers and businessmen who reaped large profits from the anti-asbestos program. There was not a shred of evidence that insulating buildings with asbestos was harmful to human health. The American economy paid the price of this wasteful campaign and, on September 11, 2001, an additional 5,000 people in the World Trade Center paid with their lives."

An article in the *New York Times* "Science Times" of December 4, 2001 (p. D1, "Wounded Buildings Offer Survival Lessons for Engineers") took note of the surprising resistance to destruction of at least one old (1907 vintage) skyscraper (at 90 West Street), which, badly fire damaged, continues to stand near the collapsed WTC complex. By contrast, the nearby forty-seven-story 7 World Trade center building *did* collapse. The terra-cotta tile fire-proofing of the 1907 building offered good heat- and fire-resistance, while the less than one-inch thick coating in the 7 World Trade Center Building proved no match for the flames of destruction. The article's author James Glanz wrote of the newer materials used to fireproof steel beams: ". . .the material is so soft and friable that it can be removed with a putty knife even after it has been in place for years. In the chaos of any terrorist attack involving a blast or an impact, many engineers have said, the material can easily be knocked off the steel, leaving it unprotected in a fire." Despite this and all the other extensive discussions in the *NYT* article, nowhere is the issue of asbestos fireproofing mentioned! This "politically correct" science reporting is mirrored in the long-term avoidance by the *New York Times* of reporting on cold fusion—or any other physics that threatens the dominant paradigm. ❑ ❑ ❑

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# Book Reviews

## A Machine Called Indomitable

by Sonny Kleinfield
ISBN 0-812912-34-9
Times Books, 1986 (Out of Print)

Review by Ron Kita

Reprinted with permission from The Center for Frontier Sciences (*Frontier Perspectives*, Fall 1998, Volume 7, Number 2).

To review a book over a decade old may seem unusual. However, the truths contained in it are as timely as ever, especially considering the current interest in biomagnetic interactions. Also, from a humanistic point of view, the book depicts Raymond Damadian as true frontier scientist. During his development of the MRI, he was portrayed as a mad scientist. His only madness was extreme unselfish dedication to his project. He is an inspiration for all of those who want to push back the edges of science.

In 1961 Damadian, after completing his residency, spent a year as a postdoctoral fellow at Washington University in St. Louis, working with Neal Bricke on the body's sodium pump problem—how the living cell manages to concentrate certain molecules while excluding others. Later, Damadian went to the Downstate Medical Center, Brooklyn, part of the State University of New York. His research there in NMR and the subsequent development of the MRI should have been labeled NMRI (Nuclear Magnetic Resonance Imaging), but Damadian believed that the term *nuclear* had negative connotations.

It was Damadian's dream to produce a device that would allow the physician to search the human body for diseases in their earliest forms. According to his theory of cell operation, he believed that a living cell functioned as an ion-exchange resin bead with respect to the way it takes in and expels molecules. This technique is used in residential and commercial ion exchangers that are used to soften water. If an atom fits into this structure, the cell holds it. If it doesn't fit, it passes out of the cell.

In water, a charged particle will always be surrounded with a water covering. Water has a dipole moment so that when a molecule of potassium or sodium is dropped into it, the tendency is for water to cluster around it. Potassium and sodium are the dominant members of the alkali metals group. Bigger molecules attract less water than smaller ones because smaller molecules have a greater charge density. So the smaller molecules, in order to stay hydrated, require more water than larger ones; potassium is a larger molecule relative to sodium.

According to Damadian, it had been observed by previous researches that when a normal cell is transformed into a wild-growing cancerous cell, the internal organization of the cell collapses. Consequently the cancerous cell fills up with water. The cell can't distinguish between sodium and potassium, so it should be possible to detect a cancerous cell from a healthy cell purely from its chemistry. Also, cancer cells are known to contain elevated levels of potassium. Damadian felt the reason was a change in the structure of the water itself. Gilbert Ling, an associate of Damadian, also believed in multiple polarized layers of water molecules.

In 1974 the National Cancer Institute funded three researchers: Damadian of SUNY, Hazzlewood of Baylor University, and Hollis of John Hopkins University to experiment with differentiating the response of cancerous tissue with respect to normal tissue(s) NMR response. The goal was to deliver a malignancy index. Damadian wanted to develop a non-proton NMR for cancer detection, but eventually the Diagnostic Branch of the NCI withdrew support and recommended that Damadian continue his imaging efforts without the branch's support. Damadian's contract with NCI was not renewed, and he never managed to cultivate many sympathetic supporters at the NCI.

Freeman Cope, a researcher at the Naval Air Research Center, subsequently became a constant source of encouragement for Damadian. Among other things Cope studied possible room-temperature superconduction mechanisms in biological systems. Within the realm of the Naval facility, he had access to the delicate instrumentation for this work. Cope continually reminded Damadian that his antagonists were simply narrow-minded. In regard to those who opposed the development of his diagnostic machine Damadian said, "The second force besides the established NMR community was the cancer establishment." Damadian notes that they simply didn't want this machine to be available since it might help to eradicate the disease. Richard Nixon put one billion dollars into cancer research for three years, but the only return on this expensive research was that the cancer rate continued to climb. The vested interests in this business are decades-deep. The sad truth is that more people are living from cancer than dying from it.

The actual development of the MRI was continually fraught with funding problems. In one instance, Damadian purchased a mailing list of the attendees of an Armenian Charity Ball, assuming fellow Armenians would gladly support his project. The list of 600 attendees cost him $600.00. After soliciting the attendees, he only received $75.00. He then went on to solicit funding from President-Elect Jimmy Carter. An arrangement to meet with Carter was made through the aid of the Plains Baptist Church's Minister, Bruce Edwards. The meeting at the church with the President only lasted a few brief minutes before Carter went on to teach Sunday School. Carter was to review a letter of introduction supplied to him by Hugh Carter after the meeting. At the Sunday morning service, Carter shook Damadian's hand and that was the last Damadian saw of him.

The quest for funding was almost as difficult as the building of the machine itself. The first machine utilized a helium-cooled superconducting magnet. Due to the extreme size of the magnet, spliced wire joints had to be butt-to-butt welded since any deformity in the wire would

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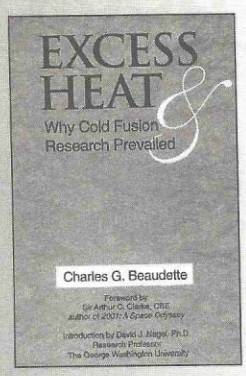
cause magnetic image resolution problems. If the splice was defective, the huge magnet had to be rewound. After many weeks, the superconductor coil was wound. The next major problem was stopping the liquid helium from leaking from the coil shroud. This required week upon week of tedious spot welding.

Damadian realized that in order to capture the imagination of the public a full-body scan of a patient was necessary; he would stop at no less a goal. When the MRI was finally completed, he faced another problem—selecting a test subject. There were no pioneer or adventurous subjects—only Damadian himself. So on May 11, 1977, Damadian himself entered the machine. It was energized but nothing happened. The situation looked hopeless; Damadian left the laboratory that night depressed. On the next day a lab technician commented on why the machine didn't work: "Maybe you're too fat." Damadian's body could well have over-loaded the MRI's antenna.

Larry Minkoff, a fellow lab worker, was finally persuaded to enter the machine. This was only after weeks of modification to the machine. On July 3, Minkoff spent nearly five hours that night inside the magnet. The results were the first magnetic image of a human chest cavity. Everyone was ecstatic over the fine results. Damadian later spent the remainder of the night at Minkoff's house, watching him sleep in order to assure himself of his subject's health. The next day Damadian attended an annual Fourth of July picnic—probably the most memorable picnic of Damadian's life—recounting his victory of the previous day.

Throughout his quest to obtain a full-body scan, Damadian was aware of the research of others in this field. It was a race—but a silent race, and Damadian was clearly the victor. Damadian realized, however, that the spotlight of victory was short. Immediately he started working on reducing the scan time down from five hours to less than one. Also, he realized that his competitors were using similar liquid helium superconducting coils. If he could design a permanent magnetic system to serve the same function as the superconducting magnet, thousands of dollars per year could be saved due to the great expense of maintaining the coils at liquid helium temperature. It wasn't an easy task, but once again Damadian prevailed.

In the decade since the book has been published, General Electric infringed on Damadian's historic patents, and Damadian (Fonar Corporation) received a settlement in excess of 100 million dollars. It was a rare case of an individual prevailing over a large corporation—Damadian versus Goliath. The NIH now is seriously investigating biomagnetic effects. A decade ago, all researchers in biomagnetics would be considered madmen. Cancer is still with us and most alternative cures are considered merely adjuncts to chemotherapy. How soon will it be until a cure for cancer is found? This book, *A Machine Called Indomitable*, is perhaps improperly titled. It should have read: *Damadian: A Man Called Indomitable*. Typical of his indomitable spirit is a final quote from Damadian: "Do you know how to spot a pioneer? He's the one with all the arrows in his back." □□□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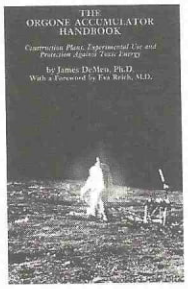


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# Gravity and Its Thermal Anomaly:

## Was the Reich-Einstein Experiment Evidence of Energy Inflow from the Aether?

Harold Aspden*

— Abstract —

*Infinite Energy* has recently drawn attention to the thermal anomaly posed by a phenomenon associated with metal boxes. What has been called "orgone" energy can, it seems, be concentrated by specially-designed metal-lined boxes, which develop a sustainable temperature rise inside the box. Here the author draws attention to a phenomenon which emerged in the 1980s pertaining to a thermal action which affected the measurement of G, the gravitation constant, where forces acting on a metal sphere housed within a Faraday cage are affected by thermal radiation, as if electric charge is induced and held on the sphere, contrary to the physical teaching that charge on metal within and connected to a metal enclosure can only exist on the enclosure surface. The author's own experiments confirm this and, given that non-neutralized electric charge is set up on and within the three-dimensional metal form, this is deemed to induce a "vacuum spin" ("aether spin") condition which induces an inflow of aether energy that is shed as excess heat.

### Introduction

One can but be fascinated by reading in *Infinite Energy* (Issue 37, 2001) first the article by Eugene Mallove (pp. 9-11)[1] and then the detailed report on reproducing the thermal anomaly of the Reich-Einstein experiment by Paulo and Alexandra Correa (pp. 12-21).[2] As someone having a special interest in energy anomalies, and particularly anomalies which point the finger at a mystery energy source hidden in the vacuum of space itself, what I read in these two accounts stirred some memories of my own past research efforts. I admit I had first heard of so-called "orgone energy" about fifteen years ago, but it made little sense to me and I tended to classify it along with psychic phenomena as something not belonging to the world of physics as I understood it. However, after seeing the experimental evidence now presented by Paulo and Alexandra Correa, it cannot be denied that a real physical phenomenon is involved and, noting that it suggests heat production without an apparent source, the nature of that source must be explored.

Given that the phenomenon concerns an anomalous thermal effect of radiation above a metal box, one involving a quite small adjustment of temperature, one wonders why Reich sought advice on the matter from Albert Einstein. No doubt he thought that endorsement of the reality of the phenomenon by such an eminent scientist would stir a general interest in funding research to establish the phenomenon and then, perhaps, the exploitation of whatever of a practical nature might emerge. Einstein was interested initially but soon lost that interest, rejecting the phenomenon as merely being something connected with heat convection by air currents around the apparatus. Accordingly, by a few published records dating from the mid-twentieth century period, the "orgone" theme has passed into history, at least until now, with the valiant contribution of the Correas in producing what the Editor-in-Chief of *Infinite Energy* has termed "a landmark article."

My contribution below is to draw attention to some references to publications concerning thermal anomalies affecting the measurements of G, the constant of gravity, anomalies which I feel sure might have reminded Einstein of Reich and would not have been ignored by him had he lived long enough to become aware of them. Also I shall outline the experiment which I performed in 1984 at the University of Southampton in England to check how thermal radiation could affect the force between two metal spheres suspended within a Faraday cage. What I found has an interesting bearing on the "orgone" experiments reported by the Correas, given a little license in speculating about "free energy" input, but by argument consistent with interpretation of several other types of anomalous "excess energy" experiments. Besides that, as a preliminary, I think it appropriate to mention an experiment reported some thirty years ago on a curious effect by which a very slow rotation of what was, in effect, a Faraday-cage could tame the wild antics of an arc discharge and stabilize its path along the spin axis.

### The Tornado Experiment and the Faraday Cage

One of the great mysteries concerning anomalous energy and anomalous angular momentum is that posed by the tornado. Somehow warm air rises to cause a radial inflow of air at near-to-ground level and somehow a tornado funnel forms with air spinning at very high speed around the axis of that funnel. Expert opinion on the source of energy is that of Vonnegut,[3] who suggested in 1960 that the trigger for that energy inflow comes from the electrical discharges we associate with thunderstorms, owing to the intense and recurrent lightning discharges known to occur within the tornado funnel. He writes: "It is possible that the vortex is initiated directly by electrical energy. . . An understanding of ball lightning may very well be necessary if the tornado puzzle is to be solved."

Here, you see, we are dealing with energy on a grand scale, bearing in mind the destructive power of a tornado, and here is an expert on the subject telling us that the source of that energy is a mystery, possibly connected with electrical phenomena of the kind involved in creating those mysterious spherical ionized objects that are occasionally seen to float around before vanishing suddenly, often with violent release of energy.

It was in a lecture I gave to physics students at the

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University of Cardiff in Wales in 1977 on the subject of "Space, Energy, and Creation" that I first drew attention to this subject, concluding with the words:

> Finally, an interesting experiment has been performed by Ryan and Vonnegut.[4] They arranged for a cage to rotate around an electric arc discharge at quite low speed and found that this stabilized the arc. The task of stabilizing an electric arc is one of the major problems of thermonuclear fusion research. It seems therefore very difficult to believe that the wild antics of the arc discharge are tamed merely by the slow rotation of a column of air. Perhaps there is vacuum spin in this experiment and it is the influence of the induced vacuum fields which stabilize the arc. Here then is more scope for research. Can an arc be stabilized in a vacuum? It is research which the modern physicist will not undertake because there is a widespread belief that the vacuum is a non-entity devoid of any special properties. It is a belief encouraged by those who believe in the development of relativity and in my experience those who believe in relativity deny the existence of the aether. On the other hand, I was once reassured by a comment Professor Cullwick[5] made about something I published. He quoted Einstein as saying: "The special theory of relativity does not compel us to deny the existence of the ether. . .there is weighty evidence in favor of the ether hypothesis."

My argument simply is that we should not be trapped into ignoring the power of the aether as a source of energy, merely because Einstein had ruled that space was a matter of geometry interwoven with the concept of time, a mathematical world that could be manipulated to fit certain observations concerning gravitation and its effect on the propagation of light. Here I was saying: "Look, there is experimental evidence that an electric arc discharge can be controlled and held in place along a straight axis merely by surrounding it by a Faraday cage and slowly turning that cage at one revolution every few seconds. Surely, if that is because of the air being dragged along inside that cage, then it is indeed incredible that such a minute influence can so affect that electrical discharge. Surely, therefore, someone should perform an experiment to reproduce the effect to see what happens when the air is extracted from the system, because if that same stabilizing effect occurs in a vacuum then here would be a major scientific discovery!"

What would that discovery be? Simply that something in the space medium itself having an electrical character has been caused to spin with that Faraday cage, something that produces in effect a radial electric field which can act on the ions in that discharge and so confine the ionization to the central region of the spin axis. Here then would be a pointer to something that not only could account for "orgone" energy anomalies but could open up the path of research on the grand energy trail and even account for why the solar system has an enormous amount of angular momentum with no counterpart to balance its origin.

In 1977 this interest was, for me, a mere hobby pursued on a theoretical basis, as I was in a senior management position in IBM as head of their European Patent Operations. It was in 1982, still in that corporate executive pursuit, that my paper entitled "Charge Induction by Thermal Radiation" was published in the *Journal of Electrostatics*. Still confined by circumstance to theoretical activity, this paper could only draw attention to aspects of physical science that warranted deeper research. The paper[6] suggested that thermal radiation could affect the measurement of the constant of gravitation where the test involved the measurement of force on a metal sphere carried by a torsional suspension within a Faraday cage.

In writing this I was speculating theoretically, having taken note of an experimental discovery by Frank Stacey and Gary Tuck of Queensland University in Australia. Hoping to arouse interest in my theory of proton creation and theoretical derivation of the proton/electron mass ratio as 1836.152, the subject of another paper,[7] I had attended a conference on precision measurement of fundamental constants held in June 1981 at the National Bureau of Standards in Gaithersburg, Maryland. The Stacey and Tuck paper[8] claimed the discovery that G, the constant of gravitation, as measured deep down in mines, was as much as 0.5% to 1.5% higher than indicated by accepted Earth-surface laboratory determinations.

I was mindful that I had written books claiming to give a theoretical evaluation of the constant of gravitation and was convinced that G could not have such a variation. There had to be some influence at work to cause those G measurements to be misleading. I was equally mindful that a chapter in my 1972 book *Modern Aether Science* was devoted to a discussion of the true cause of the Earth's atmospheric electric field, showing that it is thermal radiation from the upper to lower atmosphere that is absorbed by electrons in molecules of air to set up an electric field by their minute displacement relative to their atomic nuclei. I knew that this thermal radiation phenomenon could set up charge even on metal spheres housed within a Faraday cage and I knew from questioning Frank Stacey at that conference that Faraday cage-type enclosures were used in his G measurement to ensure that the interacting metal masses were uncharged electrically.

With this conviction I promptly wrote the *Journal of Electrostatics* paper. It was duly received by that journal on July 16, 1981. Its summary read:

> It is argued that precision measurements which rely on the use of conductive housings for electrical screening may well be subject to spurious error owing to charge induction within the housing. If the momentum transfer processes associated with the absorption of thermal radiation act selectively upon electrons, a residual charge may be induced on surfaces internal to the housing and held in place by radiation pressure. The effects of such action upon the measurement of G is discussed in relation to anomalies reported in such measurements. The phenomenon is supported by the existence of the charge on the Earth's surface. A method of testing for the presence of induced charge and eliminating its effects is indicated.

The paper was duly published and, based on some feedback I received, it was on November 23, 1982 that I prepared the following note for distribution with the paper reprints:

> Author's note on paper entitled "Charge Induction by Thermal Radiation" (H. Aspden, *Journal of Electrostatics*, 13, 71-80, 1982)
>
> My attention has been drawn to the early measurements of the effect of temperature upon G, for example by L. Southerns, *Proc. R. Soc. Lond.*, A78, 392-403



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(1906) and P.E. Shaw and N. Davy, *Proc. R. Soc. London,* 102, 46-47 (1922). The measured effects are far less than might seem to be indicated by my paper.

The reason for this is that these experiments involve heating the apparatus by processes other than those involving incident radiation and then making the measurements with the gravitating body radiating energy at a higher temperature but absorbing incident radiation from an environment still at room temperature.

It is only the radiation absorbed by the layer of atoms at the surface that results in the charge induction predicted by the theory. If the body is heated there is transfer of heat to the surface atoms by conduction and any radiation from the layer of atoms at the surface is directed equally inwards and outwards and produces a balanced radiation reaction force on this surface layer and so induces no surface charge. Half the radiation goes inwards and asserts a radiation pressure on the atoms below the surface and so causes charge displacement but no residual surface charge induction.

Experiments of the kind suggested on page 78 (of that *Journal of Electrostatics* article) aimed at verifying this phenomenon seem, therefore, warranted notwithstanding the early studies of temperature effects on G.

H. Aspden
November 23, 1982

### Charge Induction Within a Faraday Cage

It was not until 1986 that I saw in the science literature that two quite relevant and rather conflicting papers had been published. One was in the form of a news item in the Search and Discovery section of *Physics Today,* October 1986 (pp. 17-20) issue.[9] Its author was Bertram Schwartzchild and it referred to Frank Stacey's concerns about G having different values along with other earlier findings and claimed the anomalies observed were evidence of some rather curious properties of different compositions of different kinds of particle according to their baryon number. Five-dimensional space and ten-dimensional superstring theories were included in the discussion. The paper was entitled: "Reanalysis of Old Eötvos Data Suggests 5th Force. . .to Some."

The other paper,[10] also published in the same month, October 1986, appeared in *Physical Review Letters* under the title: "New Force or Thermal Gradient in Eötvos Experiment?", its authors being S.Y. Chu and R.H. Dicke, neither of whom were mentioned in the references of the *Physics Today* paper, which suggests that they were published quite independently of each other. Here the conclusion was that "systematic effects due to thermal gradients can account for the experimental data."

However, some 136 pages on in that same October 13, 1986 issue of *Physical Review Letters* there was a paper by Fischbach *et al.*,[11] which was no doubt the preview basis for the Schwartzchild report. It was entitled: "Alternative Explanations of the Eötvos Results" and this did include a direct reference to the Chu and Dicke paper. There one reads that its authors supported the baryon number interpretation, qualified by the comment:

> Although this correlation agrees with what one would expect from the presence of an intermediate range force whose source is baryon number of hypercharge, the possibility remains that the EPF (Eötvos, Pekar, and Fekete) results could be explained in terms of conventional physics. The only alternative model we know of at present which has a serious chance of explaining these results is the "thermal-gradient" model of Chu and Dicke, (CD) and for this reason the CD model deserves to be taken seriously. . .In summary, the CD model is very clever and sufficiently promising to warrant more detailed study, should ongoing experiments fail to confirm the original EPF results. The issues that it must address more fully are mechanisms for producing a temporally constant thermal gradient over a long period of time.

Not surprisingly, I found the latter contribution more in tune with my thinking but still saw that the key point about thermal radiation affecting the charged state of a supposedly uncharged metal sphere had been missed. My paper,[6] which dealt directly with such a "mechanism," was not mentioned and probably had laid unnoticed amongst the numerous papers in the numerous periodicals kept on university book shelves.

That 1982 paper refers to the experimental findings of Stacey and Tuck reported in 1981 in the journal *Nature*[12] concerning the anomalous G measurements in mine experiments and it presents the formal analysis by which the electric field gradient induced by absorbing thermal radiation pressure at spherical surfaces is calculated. For ambient temperature conditions (288° Kelvin) and based on the value of the Stefan-Boltzmann constant it was shown that the induced electric field gradient could be as high as 767 volts per meter, enough to explain the 300-500 V/m gradients observed in our local atmosphere.

That applies for surfaces of high emissivity factor (always less than one) and, as pointed out in my paper, for a polished lead sphere the emissivity factor at room temperature is 0.04, whereas for polished gold it is 0.03, and that led to my statement on the sixth page of my paper:

> It follows, therefore, that potential gradients of the order of 20 to 30 volts per metre may be induced by the radiation mechanism proposed and where polished metal spheres are enclosed in housings having highly reflective metal surfaces.

In discussing the effect of this on standard laboratory G measurements, comparing the electrostatic repulsion as between two like polarity induced charges on metal spheres, albeit housed in a Faraday cage, and not unaware that charge on metal spheres that are close together has a tendency to induce a displacement charge of opposite polarity on the facing surfaces, this giving an attraction force as partial offset, I then stated:

> Thus, we are still left with the expectation that errors of the order of 1 or 2% could creep into the measurement of G by techniques using metal spheres of the dimensions indicated.

The point here was that if the apparatus was compact and used spheres of small radius the errors attributable to charge induction by thermal radiation would be greater than for the

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case where spheres of larger radius are used.

That 1982 paper does warrant attention by those interested in G measurement, and especially given the fact that it predates the above-mentioned research reported in 1986 by the several researchers who expressed concern about these gravity-measurement anomalies.

It was between these events in 1982 and 1986 that I, having become installed at the University of Southampton in England as a Visiting Senior Research Fellow, following my early retirement from IBM in 1983, embarked upon a series of experiments, one of which, pursued during the early half of 1984, was inspired by the subject here under discussion. I did in fact write a detailed paper reporting my findings and it was submitted some three years later to the Institute of Physics in the UK for presentation at the Seventh Conference on Electrostatics (Oxford, April 8-10, 1987). It was accepted only for a Poster Session and duly presented in that form. It caused no stir, being presented to a forum of physicists concerned essentially with the hazards of static electricity arising, for example, from electric charge induction and its potential as a fire risk in oil tankers. Even though my case was supported by experimental data, it was not that welcome a suggestion to propose that electric charge induction can occur in a connected all-metal system housed within a Faraday cage. After all, such a thought goes contrary to the teachings which date from the time of Michael Faraday!

I have only now, in view of the interest developing on this "orgone" energy topic, dug deep into my research records to find that paper and, coupled with writing this report, I have posted its full text onto my website at www.energyscience.co.uk/papers/1984g.htm.

Reference to that paper will show that, even though the electrostatic forces between two metal spheres suspended on wire filaments within a Faraday cage are minute in relation to the gravitational interaction forces and even though the latter are so weak as to be not easily measured, I was able to devise a technique which overcame the difficulties. Unlike the situation for gravity, where gravity is not something one can control, I could enhance the measurement sensitivity by adding a positive charge potential to both spheres as the torsional suspension swung one way and an exactly equal negative charge potential as the suspension swung back the other way. With no intrinsic thermally-induced charge bias present, the mutual repulsive force action at any given separation distance arising from this extraneous charge condition is the same and so, for a given well regulated high applied voltage, switching between the two polarities, the separation distance of the metal spheres should hold reasonably stable. However, even a small bias charge on the spheres would mean that the progression of charge polarity reversals over time would cause the displacement to drift one way or the other, according to the polarity of that bias. The tests were rather prolonged because the natural period of the swing was 210 seconds.

The tests were performed (a) using brass spheres which had a smooth but dull appearance having been stored for years and left unpolished and (b) using brass spheres that were highly polished. The experimental finding was that under normal laboratory temperature conditions the dull spheres had an induced charge that was negative and amounted to a voltage on the spheres of 1.08V relative to the Earth connection of the Faraday cage. The corresponding induced charge on the polished spheres, also of negative potential, was 0.47V.

The title of my paper is that of the heading of this section, "Charge Induction within a Faraday Cage." It was one of my contributions to my long-lasting efforts to fathom the mysteries of gravitation. I had a theory for determining G in terms of the fundamental constants that feature in particle physics. I had written extensively on that subject and it was important for me to satisfy myself that claims that G could actually vary and not be a true fundamental constant could not stand up. There just had to be something wrong with the experimental techniques used. Now, in the event of the interest aroused by the "orgone" energy theme, with the claim that something of an anomalous energy nature is occurring where metal boxes are exposed to thermal radiation, I have begun to wonder if electric charge induction has a role to play. Accordingly, I will now conclude this account by a little speculation.

### Vacuum Spin:
### The Aether's Free Energy Inflow Mechanism

I have mentioned "vacuum spin" above by reference to that 1977 lecture I was invited to give to the physics students at Cardiff University in Wales.[13] It features many of my published contributions. A quite readable summary account is of record in *Electrostatics 1983*, UK Institute of Physics Conference Series Publication No. 66, my paper there being entitled: "The Thunderball: An Electrostatic Phenomenon."[14]

Simply put, my argument is that if you can contrive to set up a unipolarity charge condition on a disc or within a sphere, especially one that is electrically conductive, then the vacuum medium within that object will react by displacing its intrinsic electric charge radially to set up a reacting field. Although this is the same action as one has with Clerk Maxwell's electric displacement fields set up as between parallel metal plates, even where the intervening dielectric is a mere vacuum, the key difference is that the "radial" field action causes the vacuum medium to match the charge reaction by a state of spin about the axis from which that field radiates.

Accordingly, once you have set up that unipolarity charge condition, as in an ionized air formed by a lightning discharge, there can be a vacuum spin reaction by which a sphere of aether spins to set up a compensating electric field which can hold the charge and its energy stable for a while before lapsing into decay. My theory told me that the electric energy component would be that deployed from the initiating source, but that the spin developed would bring in an inflow of energy related to angular momentum and drawing on the quantum energy of the so-called "zero-point" field of the vacuum underworld. One unit of electric energy in implies one additional unit of free energy, a two-to-one gain, but as a one-off action. Only by cyclic repetition of the process can one hope to achieve a steady inflow of surplus or "free" energy and to build the gain ratio one must devise a way of recycling that electric energy.

Vacuum spin is the key to any success reported in the homopolar generators we hear about and even, I believe, in the pulsed discharge devices developed by Paulo and Alexandra Correa.[15] In one case you have a conductive disc spinning in an axial magnetic field, which implies radial electric field induction within the disc and in the other one has a contained ion discharge, with the usual and well-recognized anomalous positive glow features. The latter succeeds in sustaining excess energy generation

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because it is pulsed continuously, whereas the former exhibits anomaly transiently, as on start up, and is not easily cycled in the electrical sense.

Now, with that as background, consider the unipolar electric charge sitting on a metal sphere within a Faraday cage and held there by thermal radiation. Here the radial field exists outside the sphere. It too will induce a vacuum spin effect. The aether is caused to spin, albeit with little energy involved, but spin around that sphere. It is subjected to the Earth's magnetic field and aether in spin happens to have its own induced magnetic moment. This means that, to the extent that the Earth's magnetic field is not aligned with the aether spin axis, it will tend to precess, as does a gyroscope, owing to a turning couple exerted by the Earth's field. [One of the fascinating problems of physics is that posed by the precession of the geomagnetic N-S field axis about the Earth's N-S spin axis. Earth has a 26,000 year or so rate of precession about an axis in space parallel with a fixed axis in space as duly explained by gravitational forces. The geomagnetic axis precesses at a rate of the order of one revolution every 1,000 years owing to a magnetic couple set up by the interaction of two electrical charge systems in spin, one being charge within body Earth and one being a neutralizing charge within coextensive aether.] This will surely break up the aether spin, causing the formation of vortices, etc. This means that the vacuum spin becomes a regenerative process as these vortices decay to shed energy as heat and a succession of reacting aether regions in spin make their contribution. What this amounts to is a state where a metal object shaped in a way which approximates a cube or a sphere, so as to have a center about which induced electric displacement has a radial form, will encourage inflow of energy from the enveloping aether which energy is shed by warming the air around the object and, by convection revealing a slightly higher temperature than ambient just above that object.

As I understand the description of the experiments outlined by Paulo and Alexandra Correa in their paper in *Infinite Energy*,[2] this argument in terms of vacuum spin or, rather, "aether spin" is relevant. One must find the true explanation for that "orgone" energy mystery and here is an explanation that has much to offer in our search for a new energy source. The energy gain indicated is minute in commercial terms but its existence tells us that accepted physical teaching is lacking on this anomalous energy pursuit and, if only that fact can register in the minds of physicists in general, one can hope that they will be open to new ideas and will muster their forces in strength to broaden the field of battle and embark on a concerted crusade to break down the barriers which currently deny us access to the field of "infinite energy" which surrounds us.

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Dr. Aspden, born December 12, 1927, graduated in 1948 with first class honors in Electrical Engineering (Manchester University, England) and, after two years shop-floor training with a major heavy electrical machine manufacturer (English Electric), spent three years on Ph.D. research (Cambridge University, England) investigating an anomalous magnetization energy loss in electrical steel laminations. After a further six years with English Electric specializing in protecting the company's inventions in the energy field, Dr. Aspden became IBM's Patent Manager in the U.K. and, in 1963, was promoted to head IBM's European Patent Operations. During these years he maintained an active hobby interest in energy science (including aether theory and gravitation), published books, and struggled to get his papers in that field accepted in the face of hostile resistance. As a European Patent Attorney, he played a major role on the international patent scene during the years leading to the European Patent System. He is a past president of the Trademarks, Patents, and Designs Federation in U.K. and for five years had an official capacity in representing the International Chamber of Commerce at inter-governmental meetings concerned with intellectual property issues. In 1983, at the age of 55, he severed his patent connections, and voluntarily took early retirement from IBM, albeit with their sponsorship in his move back into academia as a Visiting Senior Research Fellow at Southampton University, England. He now has many papers of published record in scientific periodicals and operates two websites:

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# A Brief Analysis Regarding Break-even for Cold Fusion Systems: The Case for Science Before Attempting Break-even

Mitchell R. Swartz*

There has been an effort in this field to push researchers to achieve "break-even" so that a cold fusion system would produce net electrical energy. The purpose of this exercise is for the creation of such a self-enclosed break-even system (SEB system) that would "prove the existence of cold fusion." We have attempted to achieve electrical break-even since 1996, since we reported[1] the successful turn-on of small light sources using cold fusion. Since then, we have examined and developed such systems for eventual use as reactors on the far side of the Moon, to power NASA's deep space probes, and for use in biomedical systems. We have examined several methods of generating electricity from the excess heat of these reactors. The following information, arising from one of our research lines, may yield a better understanding of those conditions required for break-even and supports the reason why material science and engineering should come as first research priorities.

As we have pointed out for several years, it may be that such premature attempts to attain break-even by electrical conversion, or by other self-sustaining behavior, may be wrong at this time for at least three reasons: First, the fact remains that if skeptics are unimpressed by the autoradiography of the electrodes and emission of low-level, non-penetrating radiation,[2] tritium production,[3,4] power-correlated helium-4,[5] helium-3,[6] and significant excess heat signatures clustered in optimal operating points (OOP),[7-10] then they are unlikely to be moved by an SEB system.

Second, break-even should be the goalpost after achieving detailed understanding of these complex systems, their operation, reactions, the stereo-constellation of their material distributions, and their limitations. Perhaps the most important matter revealed by this analysis and previous studies is that excessive removal of heat from cold fusion systems (which is required to make electricity) can inhibit, and can eliminate, the desired reactions[11,12] for reasons involving loss of cooperative feedback[13] and loss of phonon pool.[14]

Third, supporting the second reason, the OOP should be maximized first[15-17] because of the problem associated with loss of power due to the feedback required to make an over-unity system a SEB system. This can be understood more easily with the following analogy and analysis addressing the difference between "over-unity" and break-even.

We define "over-unity" as the achievement of increased output for a given input power. Cold fusion is included here but is not considered over-unity by some, because it involves nuclear reactions which give up nuclear binding energy to the lattice. "Over-unity" is the equivalent of suddenly having possession of a machine that legally converts a one dollar bill to a ten dollar bill. Eventually, even with this magical device, the gedanken individual running it will run out of dollar bills. What is needed is a bank to convert some of the ten dollar bills to ones, and "feed" the system. However, without a bank to convert the ten dollar bills back to one dollar bills, and without a way to feed them back to the input of the device, there is no energy feedback, and so there is neither further input nor break-even. *Therefore, the system's functionality ceases.* We define true break-even as the successful utilization of a portion of the output returned back to the input to provide input sufficient to drive the system into an autonomous mode—a true self-enclosed break-even (SEB) system.

The analysis assumes the successful attainment of break-even and the conversion of heat from fusion systems into useful electricity. The analysis considers the output power achieved in terms of the power gain, and then examines the net output after consideration of the electric power which is "lost" and required to "close the loop" and maintain system input.

That power lost goes through the "loop" unavoidably because it is absolutely required to achieve continuation of the reactions necessary for true break-even mode. Unfortunately, to make the matter worse, the loop power is lost in a very inefficient manner because every system which has been investigated for converting heat to electricity yields an efficiency less (and usually much less) than 1.0. Our efforts have ranged 0.0075 (steam engine) to about 0.17-0.35 (thermoelectric). This poor efficiency results because of Carnot efficiency considerations. [Other unavoidable heat losses, gas stream losses, and other inefficiencies of the reactor are not considered here.]

Figure 1 shows the results of many analyses of our systems. It considers 10 watts input power. The figure shows the net output power of a gedanken reactor as a function of power gain and the loop power required to actually achieve break-even quality output factor as a function of the loop power (in watts) for varying power gains. The efficiencies shown in Figure 1 range from 15% to 45%, latter of which may be optimistic for electricity generation considering the usual Carnot efficiencies (and other losses) actually observed. Nonetheless, the figure is very instructive with the proviso note that any "output" less than zero is fictitious, and the numbers are merely given so as to show a "negative rating" demonstrating exactly how bad that system setting performance would be. In fact, the output would be zero.

It should be noted that, as expected, for all systems with power gains of one or less (non-nuclear systems), the net power out is always less than one. Attention is directed to the fact that for cold fusion systems with power gains of 200% or less, the net power out is always less than one for these optimistic efficiencies. With present efficiencies, cold fusion systems must have power gains of 400% or more to yield a useful net power out if any break-even systems are contemplated.

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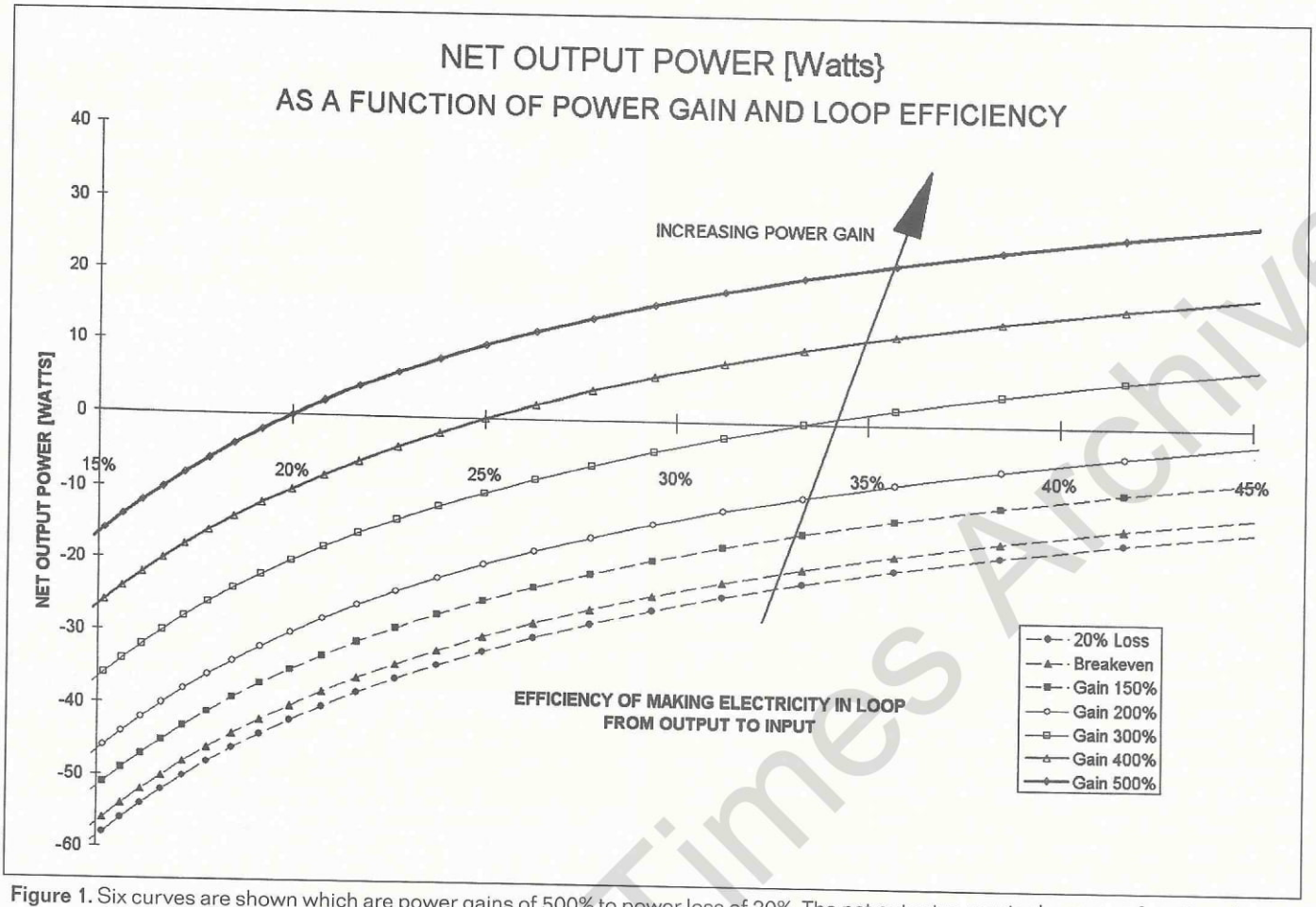


**Figure 1.** Six curves are shown which are power gains of 500% to power loss of 20%. The net output power is shown as a function of power gain and the efficiency of electric conversion from heat required in the loop.

One criticism of this work is that some cold fusion systems, such as the gas loaded mixed Pd-C systems (as described by Case and George and McKubre *et al.*), are purported to be close to self-sustaining now, and therefore this analysis may be obsolete. Hopefully so. However, quality assurance requires that those experimental setups be converted from thermometry to precision calorimetry (with full controls included step function, joule and chemical controls) and that the noise power of those systems be routinely measured, and considered as input, so that the corrected outputs can be semi-quantitatively derived.

This analysis might seem pessimistic for the field, but the engineering of successfully designed systems requires the evaluation of all possible reasons for failure,[18] ranging from estimations of power dissipation within the system to avoiding those problems discussed here.

This brief analysis demonstrates again the great importance of research which focuses on maximizing power gain first—before achieving break-even. Thereafter, the impact of the break-even systems will be made by control of these systems through driving them at their optimal operating points. This will provide future autonomous electric devices for biomedical, terrestrial, and deep space projects.

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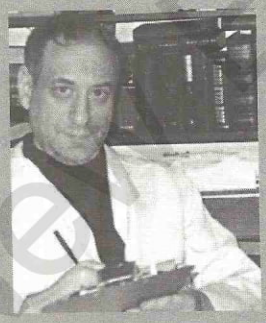

Dr. Mitchell R. Swartz (Sc.D., MIT, 1984; M.D., Harvard University, 1978; EE, MS, and BSEE, MIT, 1971) has contributed broadly to the fusion and energy literature on issues including quality-control in calorimetric analysis, proton transfer reactions at electrodes required for fuel loading, and phonon-material interactions. His current research investigations at JET Energy Technology, Inc. include engineering of, and material development for, low temperature fusion systems, nuclear transmutation, break-even studies, and the more efficient use of computed systems for the integration of power generating systems.

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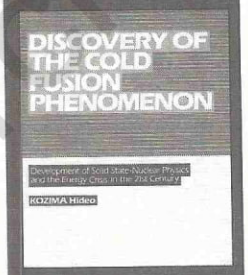


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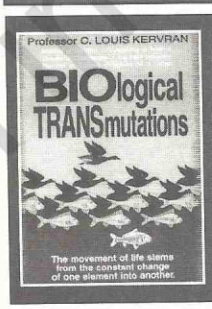


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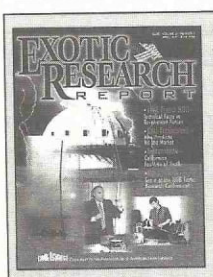


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# Momentary Mass Reduction and Enhanced Quantum Tunneling Within Perturbed Coherent Matter

B.A. Small*

**Listed below are fourteen proposals that seem to help explain the phenomena of exothermic cold fusion, endothermic cold fusion, cold fission, cluster-impact fusion, cavitation energy, biological transmutations, decay-rate acceleration in radioactive materials, collapsing hydrogen atoms, and what is said to be ancient alchemy.**

1. Because of the law of the conservation of linear momentum, radiationless nuclear reactions most obviously involve momentumless or nearly momentumless collisions.

2. Because of the necessity of greatly enhancing energy barrier tunneling in cold nuclear reactions, momentumless or nearly momentumless collisions are best explained by a mechanism of momentary mass reduction.

3. Momentary mass reduction can routinely arise in perturbed coherent matter because the mass of any particle is not necessarily a fixed attribute of that particle alone but is dependent upon where that particle resides within any number of overlapping potential-energy wells.

4. Perturbations to coherent matter can often initiate transitions between the quantized energy levels existing within a microphysical coherence domain. If insufficient energy is present to complete such a quantized transition, then this can result in a mass-modifying reorganization of the various overlapping and entrapping potential-energy wells.

In effect, the mass of an atom in a perturbed coherence collective can be momentarily diminished, temporarily sacrificed, in order to maintain the quantized vibrational state of the larger group of atoms in the remaining collective. Furthermore, it is reasonable to assume that the mass of an atom can be reduced all the way to zero and can simply cease to exist, at least for the time limit that is established by the uncertainty principle. Perhaps this process of momentary mass reduction could be expressed more eloquently as the result of an interaction between a transitional negative-energy "wave" function and a quantum system of macroscopic dimensions.

5. Material coherence appears to be an ancient concept that is central to the scientific theory of alchemy. Modern chemists might refer to material coherence in terms of London forces and latent heats. Material coherence itself occurs when momentary fluctuations in the electronic symmetry of an atom induce complementary fluctuations in other nearby atoms. Coherence contributes to the interatomic forces that allow atoms to cluster together and form condensed matter. Moreover, since a charge and an induced opposite charge attract, coherent interatomic oscillations naturally lead to a lower energy condition among the atoms that are organized into coherence domains than would be the case for the same atoms merely vibrating randomly.

The lower energy condition of a coherent cluster is its binding energy, and this binding mass-energy contributes to the heats of phase transformations for a substance. By the localization-quantization theorem, the lower energy condition of a coherently vibrating group of atoms logically becomes a self-entrapping, self-localizing, and self-quantizing condition. Apparently, in non-over-unity situations, the atoms in a coherent cluster can be returned to something like their earlier state of greater randomness by merely being exactly and non-abruptly resupplied with the energy released during their original process of coherently binding together. Finally, the force of alchemical coherence usually increases with increasing pressure and increasing atomic number.

6. The quantum description of a single particle trapped in a box may be a useful analog in understanding and applying the complex patterns of energy-shunting standing waves occurring within a coherent cluster of particles. This description may be especially useful when one considers that the "box" can be in one, two, or three dimensions.

7. Coherence domains that have been nano-engineered as thin films afford a larger step size between the quantized energy levels existing within the coherence collective. The larger step size is important because the degree of mass reduction depends upon the degree of incompleteness in the transitions between collective energy levels. In effect, the interface provides a secluded area, a sanctuary, where macroscopic quantum events of a larger step size can occur. A more flowery description of the importance of reactions at the interface would be to say that the power of coherence moves upon the face of the deep.

8. A coherence domain can be perturbed by many different micromechanical fracturing techniques or by direct stimulation with certain frequencies from the electromagnetic spectrum or by emissions of radiant energy that drop the coherence domain down between its own resonance frequencies. A drop between natural resonance frequencies appears to be the cause of the thermal-memory effect.

9. For nuclei of a standard mass, transitions between energy levels typically yields hard gamma radiation. The paucity of gamma radiation in most alchemy experiments could, therefore, reasonably indicate the presence of nuclei of a non-standard mass-energy. Mass reduction, thus, certainly seems, once again, to be the key to understanding radiationless nuclear reactions.

By contrast, if the coherence domains in cluster-impact experiments or out-diffusion experiments are broken with

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enough velocity (and therefore enough collision momentum) having been imparted to the reactants, then radiation should occur. That radiation does occur in such experiments tends to confirm the idea that quantum tunneling is now being enhanced by both a minimal amount of externally imparted momentum and a pre-existing or pre-reaction mass reduction. Also, it should be noted that this idea of a pre-reaction mass reduction seems to be simpler and more explanatory than a post-reaction energy-to-lattice coupling mechanism.

**10.** By repeatedly breaking the microphysical correlation domains in a radioactive solid, it should be possible to test the enhanced-quantum-tunneling effect of perturbing coherent matter. The radioactive materials used for this test should be chosen so that they do not decay by electron capture, and, thus, the radioactivity of these materials would not be expected to be pressure sensitive. Also, all forms of water and hydrogen should be rigorously excluded from this experiment as possibly complicating factors. The crystalline radioactive materials should be thoroughly ground up for a long period of time. Next, the resulting powdered substance should be melted, abruptly distilled, and, then, recrystallized. This entire process of transmutation via perturbation and distillation should be repeated many times to essentially grind the radioactivity right out of the substance.

After having been subjected to this alchemical "cross of changes," an extensively processed sample should have its remaining radioactivity compared with that of a materially unfatigued control sample. A relative reduction in the radioactivity of an extensively processed sample could indicate enhanced quantum tunneling. Moreover, any diminished radioactivity would tend to confirm a mechanism of localized mass reduction as the cause of the enhanced quantum tunneling; this is true because the disintegrations caused by the enhanced quantum tunneling would occur through the nuclear-force barrier, as distinguished from the coulombic barrier.

**11.** The stated ability of hydrogen isotopes to reduce radioactivity in other substances is probably mostly due to the repeated perturbing of the interfacial coherence domains in those other substances. However, there may be a second, even more subtle mechanism involved.

Mainstream physics accepts that once particles have been entangled they will tend to remain entangled, as if matter possesses a kind of correlation memory. Furthermore, mainstream physics also accepts that superluminal phenomena, which can even occur across great distances, are common in systems that have been quantum correlated. Consequently, the question arises: Is it possible to prepare hydrogen or alchemical substances in general so that these substances possess a superluminally time-shared mass deficit that could persist even in the gas phase? In such a case, all of the original atoms of a former coherence domain might possibly still remain; it is just that these atoms would now each momentarily share in the missing binding mass-energy of their former coherence domain. Moreover, this proposed time-shared mass deficit would be mathematically covariant with momentarily contracting electronic orbitals so that the novelty of alchemical materials would not be easily revealed by early forms of spectroscopy.

If such an unseen interconnectedness among the atoms of a former coherence domain can be proven, then perhaps alchemy's skeptics and believers alike will be more clearly shown to have been touching the same elephant after all. Also, the appropriateness of the name "hydrino" could only be enhanced by the concept of a gas-phase persistent, time-shared mass deficit. Perhaps this proposed second mechanism could be tested completely within the gas phase by attempting a comparative hydrogen-versus-hydrino remediation of various radioactive gases or, alternatively, by a thermal-energy-only transmutation of low-pressure oxygen and vaporous sodium into potassium.

**12.** In addition to any possible electron screening of the nuclear charge that might be afforded by momentarily contracting electronic orbitals, science should ask if mass reduction also offers a related third mechanism for enhancing cold nuclear reactions. Specifically, how would a charged particle itself behave when, according to the rigors of harmony, its mass is temporarily reduced either to zero or nearly to zero? Would a charged particle's charge temporarily delocalize or even temporarily disappear, undergo some sort of coulombic annihilation, during such an extreme mass reduction? Would a proton and an electron behave differently during an extreme mass reduction? If so, then would their differing behaviors be the result of their differing masses or their theoretically differing internal constructions? Is mass-related coulombic annihilation a third mechanism for enhancing alchemical reactions? Have such notions already been envisioned almost seventeen centuries ago by Zosimos of Panopolis?

Could coulombic annihilation help to better explain the reports of negative electrical resistance, the reports of room-temperature superconductivity in alchemical substances, the reports of anomalous static electrical charges building up on some cold fusion experiments, or the reports of apparent electroplating occurring in rotary cavitation systems and some automobile radiators? Furthermore, could coulombic annihilation help to better explain the electrical charges and magnetism that are associated with stars and geologically active planets?

**13.** Neutrons of a momentarily lowered mass should decay at a faster rate than neutrons of a strictly standard mass. By the reversibility of elementary events, low-mass protons should, therefore, be expected to capture antineutrinos at a faster rate than standard protons. Can the energy gained from absorbed antineutrinos help to measurably explain the apparent endothermic character of some cold fusion reactions? Also, could thin films of alchemical materials, a sort of chip-based alchemy, be used to fashion a neutrino telescope?

**14.** The mind can sometimes see what the eyes cannot. We can use philosophy to see the invisible and, therefore, do the impossible. In earlier times, the microphysical coherence domain or some multiply-entangled, excluded-state modification of the coherence domain seems to have been known as the philosopher's stone.

**About the Author**
Brian A. Small has an A.S. degree in chemistry with a minor in mathematics. He graduated with honors.

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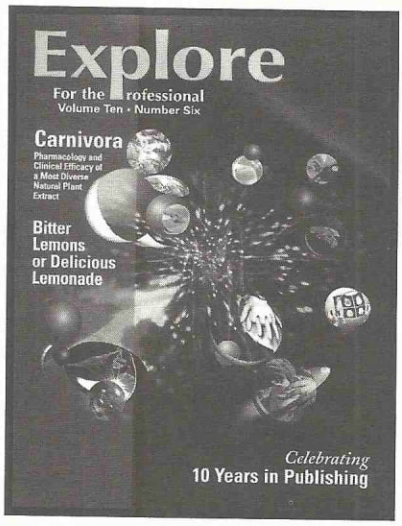


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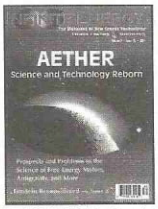

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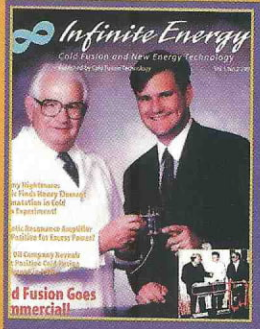


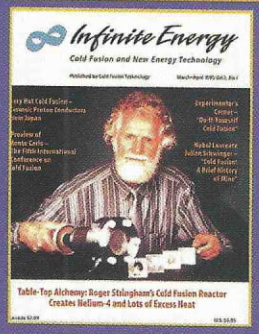


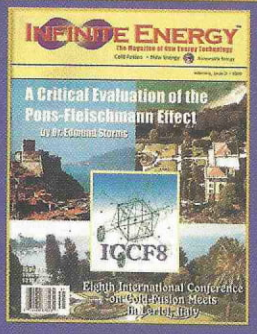


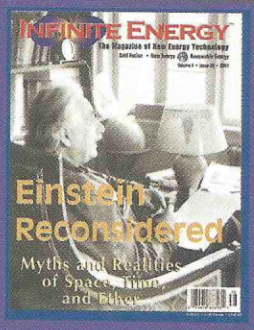

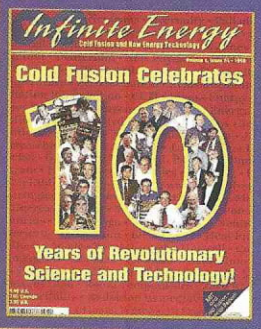


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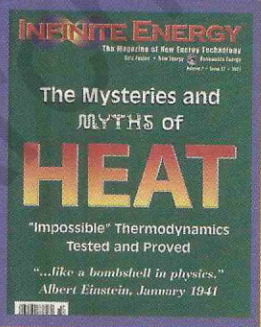


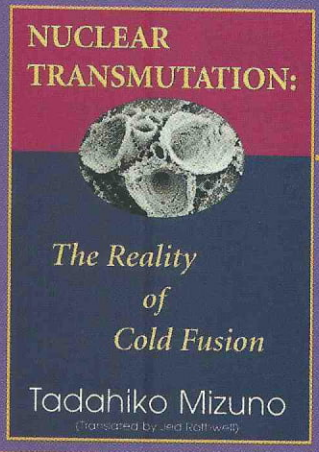


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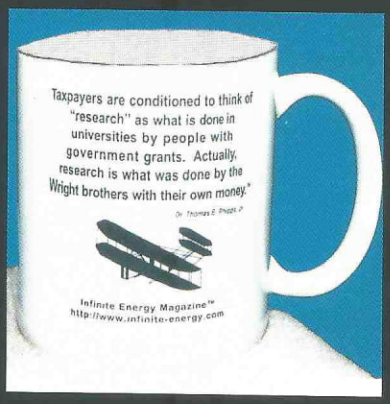


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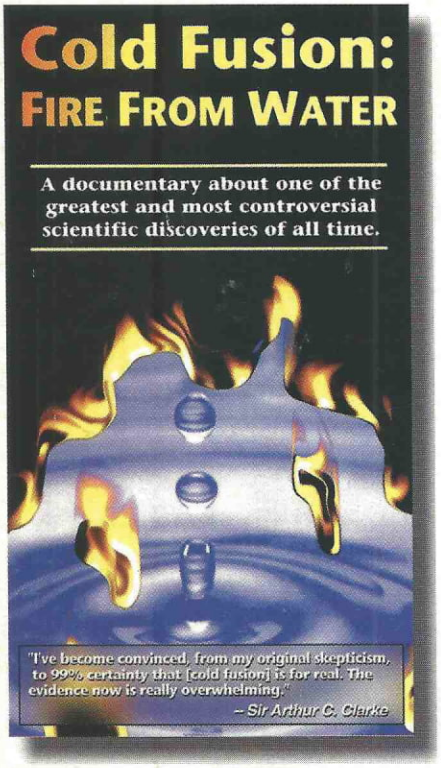


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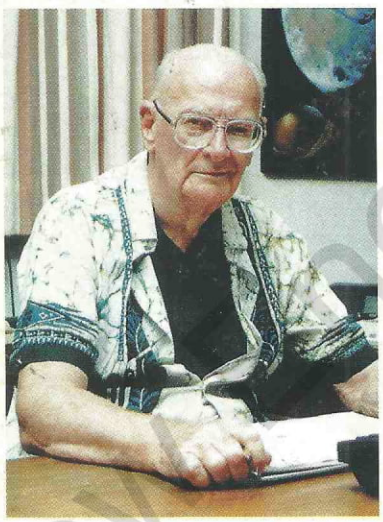

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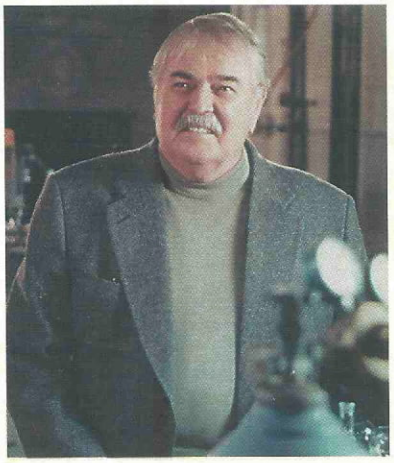

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